THE AMERICAN GAS LIGHT JOURNAL

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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS.

An Asterisk (*) Denotes an Illustrated Article.

OFFICIAL NOTICE—

Third Annual Meeting, Commercial Gas Association..... 969

EDITORIAL—

Briefly Told..... 969

The November Conference of the Employees of the Westchester Lighting Company—Current Mention.

*The Light-Tinker, by "R."..... 970

*Modern Wrought Gas Pipe, by Mr. F. N. Speller..... 971

Report of Sub-Committee on Calorimetry, The American Gas Institute..... 973

The Financial Problems of the Manager, by Mr. F. T. Hulswit..... 980

CORRESPONDENCE—

Some Useful Ways for Applying Electric Heat..... 982

ITEMS OF INTEREST FROM VARIOUS LOCALITIES..... 982

Contract for Western Gas Construction Company—The Latter's Shops on Full Time—The Saginaw (Mich.) Rate Decision—Readjusting Gas Rates, Galesburg, Ills.—Sale of the New Bern Company—The Sale of the Suffolk (Va.) Plant—The Brown Hoisting Machinery Company's Bucket Catalogue—Rate at Louisville will not be Changed—The Green Mountain Lighting Company—Going Ahead at La Porte, Ind.—Gen. Manager Searle Conquers Greece. N. Y.—Justice Was Done—Something from Norfolk, Va.—Annual Meeting, Suffern, N.Y. Personal—Ruth A. Corn Won the Money—Death of Mr. John P. Griffin—The New Plant at Parkesburg, Pa.—Troubles of the Catskill (N. Y.) Illuminating Company—And Other Items.

The Market for Gas Securities..... 984

[OFFICIAL NOTICE.]

Third Annual Meeting, Commercial Gas Association.

NATIONAL COMMERCIAL GAS ASSOCIATION,
OFFICE OF THE PRESIDENT,
DENVER, COL., November 27th, 1908.

To the Members, National Commercial Gas Association: The next meeting of the National Commercial Gas Association will be held in Chicago, December 8th, 9th and 10th, 1908, the meeting place being the First Regiment Armory, corner Michigan avenue and Sixteenth street.

In connection with the meeting of the Association an exhibition of gas burning appliances will be held. This exhibition is conducted by a committee appointed from the membership of the National Commercial Gas Association and the American Gas Institute. The Committee report that all of the spaces for the exhibition have been taken, which insures the giving of the largest exhibition yet undertaken.

The meetings of the Association will be held from 10 A.M. to 2 P.M. each day, after which time a lunch will be served to those in attendance, and the exhibition will then be open for the balance of the afternoon and during the evening.

The Auditorium has been selected as headquarters and those desiring to attend must write to them promptly in order to secure reservations.

The list of papers to be presented at the meeting is as follows:

"Selling Gas During Depression," by Frank A. Willard, Rochester, N. Y.

"Advertising of a Public Service Corporation," by E. St. Elmo Lewis, Detroit, Mich.

"Industrial Fuel Gas and Special Appliances," by S. Tully Willson, Denver, Col.

"Exhibition of Appliances a Necessity in Purchasing," by Henry L. Doherty, New York City.

"Complaint and Application Departments, with New Business Departments," by A. von Dachenhausen, Butte, Mont.

"Records of New Business Departments," by Charles M. Cohn, Baltimore, Md.

"The Consumer," by C. Willing Hare, Philadelphia, Pa.

"Methods of Increasing Gas Sales in a Small Town," by Glen R. Trumbull, Lebanon, Pa.

"Model Kitchens," by George W. Thomson, Chester, Pa.

"Demonstration Work," by Mrs. Helen Armstrong, Chicago, Ills.

"Compiled Record of New Business Methods," by George Williams, New York City.

"Gas for Lighting," by B. O. Tippy, Grand Rapids, Mich.

"Meeting Competition from High Efficiency Lamps," by T. J. Litle, Jr., Gloucester, N. J.

"Marketing of Coke," by R. A. Field, Rome, N. Y.

"Qualification for and Training of a Solicitor," by H. C. Porter, Lincoln, Neb.

This is the first convention of the Association held in the West, and indications already point to a large attendance.

Yours very truly, FRANK W. FRUEAUFF, President.

BRIEFLY TOLD.

THE NOVEMBER CONFERENCE OF THE EMPLOYEES OF THE WESTCHESTER LIGHTING COMPANY.—As we predicted would be the case, the November meeting of the employees of the Westchester Lighting Company was successfully carried out, at the appointed time, in the handsome auditorium available for such gatherings at the home headquarters of the Company, Mount Vernon, N. Y. It was known, of course, that the attendance would be of the numerous sort, but we venture the suggestion that not even the Company's clever Vice President (Mr. Wm. J. Clark), and likely the one who has given the greatest share of counsel and encouragement in the formation of the Company's men on these lines of fraternity, was altogether unsurpassed for an attendance which certainly figured not less than 230. There can be no doubt whatever as to the good this kind of "clubbing" is to secure for the Company and its men, between whom

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comradeship of such close degree promotes. For it may not be truthfully denied that one willing worker is worth two unwilling ones at best, to say nothing about the further gain in the quality of the work done, and that gain made without any increase in the supervision staff. The Company is largely engaged in the distribution of both gas and electrical currents, wherefore it was necessary that each division should have something of its own to especially interest its factors. Regarding the electrical branch, the special for the evening was an interesting and picturesque display and exhibition of wire handling on a model electric line. Practical poles were set and wires strung in the assembly room, and an expert was sent up to the pole top. He worked actively over the cross arms, among supposedly live wires, giving a splendidly practical demonstration of how lines might be disentangled and cleared, to the end that an interrupted service might be restored quickly and safely. He was, of course, accoutered with all the paraphernalia that the lineman needs in making repairs. The gas division was entertained through a live discussion of several questions taken at random from the Question Box. The queries were of a general character and the discussion was brisk, continued and profitable. They were of a general character, which fact was all the more acceptable, since their generality made it possible for a large number to take part, and provided opportunity for some of those "higher up" in the ranks to lay down the law as that is dispensed from the widely separated division headquarters of the Westchester corporation. The attractive piece, in which both gas and electric divisions could share, was a lecture on "First Aid to the Injured," excellently delivered by Dr. Thomas F. Goodwin, of Mount Vernon. Sensible man that he is, the Doctor in his explainings never attempted to go over the heads of his audience, with the result that no echoes of whispered queries were heard during the speaker's presentation of his subject—it was quite different, however, in this instance when the lecture *per se* was at an end. The force of the text was greatly added to, and its effectiveness as well, when a well put on set of lantern slides, to which was added further perspicacity by the manipulating according to the regulations of a physical demonstration subject, who completed the fine work by an artful simulation of coma. The entertainment in lighter vein was all by home talent, whose diversified skill was shown in a smoothly brought off calendar of recitations, interspersed with vocal and instrumental music that did good credit to its renderers. Dr. Stillwell, of the Company's executive staff, who is ever ready at these gatherings to add to their interest, spoke in happy vein regarding the value of co-operation and the doing of conscientious work as mutual aides to advancement and success. In this recital he gave a concise recounting of the progress made in the Company's Mutual Aid Society, which youthful organization—it was formed last August—shows a membership of 259. Under the scale arranged the benefits accruing to its members are a sick benefit of $6 per week, and also a mortuary payment of $100. To sum it up, the Westchester Company's Club at its last meeting gave evidence that its formation was not hasty and that its life is to be long. It might also be noted that this meeting was the first one (as between the gas and electric sections of any corporation) at which the chief topic of related interest was the discussion of the topic of "First Aid to the Injured."

CURRENT MENTION.—

LAST week we noted that Mr. Harry Firstbrook had been appointed Superintendent at Biloxi, Miss., which is undoubtedly true, in that he was there for quite a while. In fact his work was so good there that his Directors, who are also virtually those in control at Bessemer, Ala., thought his promotion to the latter charge would be the right thing to do.

THE lecture for the December meeting of the New York Section, Illuminating Engineering Society, will be delivered Thursday in the lecture room of the United Engineering Societies' Building, by Dr. C. P. Steinmetz. His theme will be "Illumination and Illuminating Engineering."

MR. H. W. HODSON, of Bryan Donkin & Co., Chesterfield, England, sailed for home the 28th ult. He surely is a clever gentleman, and his hope to us on leaving that "this would not be his last visit to America," we wish may not be in vain.

LAST week we noted that a café in Chicago, which is beautifully illuminated by means of reflex gas lamps, is located at the northwest corner of Wabash avenue and Madison street. The precise location, however, is at the northeast corner. To box the compass aright one must box it properly.

The Light-Tinker.

[Prepared for the JOURNAL, by "R."]

Within the past few years specialists have appeared in every field. Men who have made a study of shop and factory economics go about the country with a view of inspecting certain plants for the purpose of suggesting improvements and economies for a stipulated sum; again, there are men who make a specialty of employees. These men will go to a gas plant, a mill or other place where employees are engaged, and make a study of each person and the work done by him. A report is made on how to get better and more effective service from each and every employee, and a stipulated sum is received by the help-economy expert at the end of the inspection. There are men who devote time, skill and efforts to the improving of the power system of a plant, who will enter a plant and take notes on defective adjustments of belts and wheels, and then will draw plans of improved methods of getting more power at less cost, and so on. Then there are men who give their attention exclusively to the waste question. Wastage of materials, labor, time, etc., are considered and estimated upon and proper suggestions made to remedy evils along this line.

This article is devoted to the light-tinker, so called. The light-tinker is the man who sprang into existence in modern times, or since the light question has become one of much importance in the manufacturing establishment, the office, the store, the house, the park, the street.

As long as manufacturers were content to let their help toil along in the early morning and late afternoon in dim light, there was not much need of the light expert, and office lamps were not actually required to be brilliant some years ago. Dusty lamp chimneys and poor lights were the rule in many a household, and nobody seemed to care very much. Street lighting was dim, and only a few scattering lights could be found in the parks. The big advertisers with their lighted signs had not come on the scene; but the conditions have been altering. Indeed, it is very different now, even in the country towns. Light experts are doing considerable business. Light-tinkering as a profession has been improving in many ways. There is money in the occupation, and those who follow it have a great chance to improve the lighting facilities of the plant, the office, the store and the home.

The light-tinker began his operations in the private house. It is supposed that some gas man out of a job undertook the work of investigation at houses with the object of improving the lighting system of these for a stipulated sum. From the house-to-house canvass the occupation has developed and spread to the artistic advertising lights used by the great firms of the country. In between are the numerous descriptions of lights employed for various purposes.

The light-tinker goes to the house, the office, the store or the mill, and observes things. He notices that the adjustment of the fixtures is not to best advantage and offers to remedy the same.

The show window lights of the store are making too many shadows, and this must be changed. The lights over the office desk are so set that the bookkeepers are handicapped with reflections on the book pages due to shadows from pens and pencils. The light expert carries a kit of tools, and some minor part of the gas fixtures too, and is able to do considerable rectifying then and there. If the job is a large one he calls at the nearest gas fixture store and obtains the needed equipment. In many instances the light-tinker finds the necessary remedy to the light system by giving his attention to the globes. He finds cracked and broken globes, as in Fig. 1, and replaces the same with new. Some of the globes are choked with soot, as in Fig. 2, and he goes to work with the required articles, cleaning the same and improving the light accordingly. He finds that some of the lava tips in the gas jets are broken, or minus, resulting in a jet of flame striking against the edge of the globe, as at *A*, Fig. 3. This trouble is quickly adjusted with a new tip, for a variety of tips is carried by the light man.

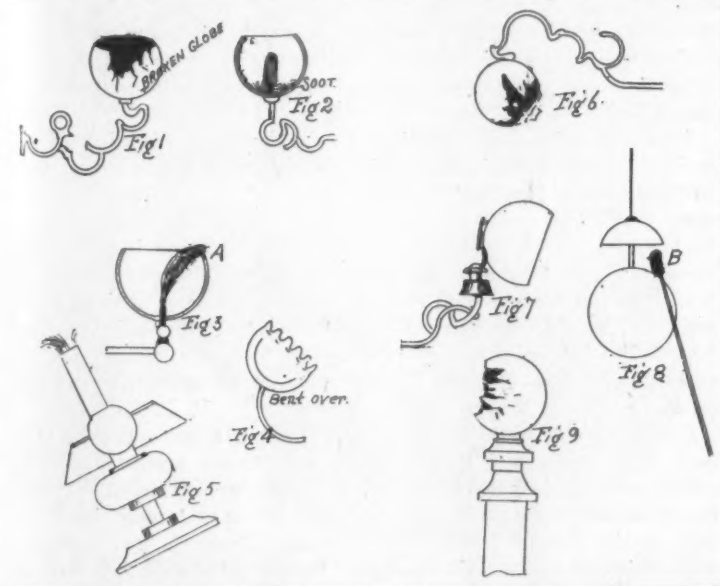
Then he finds globes with the stands bent over and out of order, as shown in Fig. 4, and a little exertion on his part on the combination sets things to rights and the light burns better. The light expert keeps an eye open for any dangerous lights. One man upon entering a room noticed the party at the desk rise and tilt the table so that the oil light assumed the angle in Fig. 5. A conflagration was narrowly averted. The light man used this incident as an argument for the installation of modern fixtures for gas lighting.

The light expert has a wonderful opportunity to advertise new

goods, and some of the light-tinkers are in the pay of concerns who give them rich commissions on sales. The commission is always a welcome present to the hard working tinker. The latter finds that the modern practice of tilting the globe in various directions adds somewhat to his troubles. He finds some people who want the whole system of fixtures converted. There are upside-down styles, and sometimes the housewife does the turning over of the fixture herself. The light man finds the fixture revolved, as in Fig. 6. Because the fixture was not made to burn that way, the flame cracks the globe at once. The light-tinker may, however, put in the right fittings for the inverted globe and there will be no trouble.

Fig. 7 shows one way in which the globe is set for artistic purposes, and Fig. 8 shows one of the little cleaning sticks used by one light expert, which consists of a metal rod, about the end, *B*, of which is adjusted the bristle head for cleaning purposes.

The light-tinker often does quite a business in hall light globes. He finds a globe in a broken condition, as in Fig. 9, and offers to replace it with one of modern design. Sometimes he has an assortment of artistically decorated glass globes with him. Not infrequently the light expert works up his patronage to such extent that he can travel with an automobile and carry an outfit with him. As a rule, however, the light-tinker of to-day possesses only his kit-box, and this he carries in his hand, grip-fashion.



Modern Wrought Gas Pipe.

[Written for the Third Annual Meeting, American Gas Institute, by Mr. F. N. Speller, Pittsburgh, Pa.]

Progress in manufacture is best made by cordial interchange of experience between consumer and producer. A clear discussion of the facts and conditions of service (not hearsay) will soon develop the weak points of an article which the truly progressive manufacturer will then endeavor to overcome to the advantage of all concerned. It often develops that a new material requires a variation in the method of handling to obtain the best results; here the manufacturer with his experience can help the consumer in his difficulty. It is at such meetings as this that interchange of experience is best brought out, and it is with this object in view that I have accepted the invitation to open this subject.

Material for Service Lines.—At the time welded pipe was first made, puddled iron was the only material available, and for years after steel became known it was not considered for this purpose. In the development of metallurgy of steel it was found that a soft iron, practically free from carbon, and with a much lower percentage of foreign impurities, could be made by other process than the old method of puddling. This metal was first tried about 1886 in the manufacture of pipe. The difficulties were naturally encountered at first, but have been gradually overcome as experience was accumulated. Although classed under the general head of "Steel," this form of refined iron cannot be hardened by quenching from a red heat, and is easier to weld than puddled iron. Now we have a metal which is especially adapted to meet the modern demands in quality, quantity and low cost.

These requirements are obtained in what we call "Pipe Steel" by placing the responsibility of the output in the hands of a few highly skilled operators, by running the rolling mills and welding departments in close touch with the steel works, and by keeping the plant exclusively engaged in the manufacture of this steel day-after-day. This method of operation is essential to the best results in the mill, and at the same time the uniformity of welding quality so obtained insures a high degree of uniformity in other respects; for passing through the welding furnace is an ordeal that effectually reveals irregularities and unsound metal.

At present about 80 per cent. of the demand is for steel pipe. In some cases, where strength and ductility are important, steel is insisted upon, but for the majority of uses where the metal is up to standard, either can be used. The steel has, however, nowadays, a general advantage over the iron in being more uniform in quality and, considering everything, there seems to be no doubt that experience has shown it to be the standard material for welded pipe of the future. Early experience in the use of steel for this purpose taught that certain special treatment was necessary in order to obtain the best welding quality and to enable it to stand the temperature required without undue crystallization. A certain amount of steel pipe doubtless got out in those days which would to-day be scrapped by the mill inspectors and charged up to the department from whence it came. The fact that manufacturers of iron bedsteads and electric conduits ask for this soft steel pipe, and bend so much of it cold, into all manner of shapes without practically any trouble, is satisfactory evidence to us that this is the most reliable material for the purpose. Vibratory tests on steel and iron signal pipe given below show the relative endurance of these materials under such stresses.

Table 1.—*General Physical Properties and Chemical Composition of Wrought Iron and Steel Pipe.*

Chemical Analysis.	Steel.	Wrought Iron.
Silicon	.01	....
Sulphur	.050	.030
Phosphorus	.100	.170
Manganese	.30	trace
Carbon	.07	trace (irregular)
Oxides	.10	1.20–2 per cent.
Physical Properties.		*(Pulled Longitudinally.)
Tensile strength	58,000 lbs. per sq. in.	46,000 lbs. per sq. in.
Elastic limit	34,000 lbs. per sq. in.	28,000 lbs. per sq. in.
Elongation	22 per cent. in 8 ins.	12 per cent. in 8 ins.
Reduction in area	55 per cent.	25 per cent.

*These figures would be considerably less if tests were made transverse to direction of rolling; the steel is practically of the same strength in all directions.

Table 2.—*Test Made on a 1-Inch Pipe on the Olsen Staybolt Machine. Deflection 5-32 Inch in 8½ Inch.*

Average Results.

Series 1.	Load to Deflect. 5-32.	No. of Revolutions. Steel.	No. of Revolutions. Iron.
(6 pieces of each)	772 pounds.	16,178	6,940
Series 2.			
(10 pieces of each)	....	13,555	8,764

The man who insists on buying wrought iron gets a pipe of about ⅓ the bursting strength, less ductility (as illustrated by samples), and pays a good premium for it into the bargain. The introduction of a change in material in the manufacture of an article having such a widespread use as pipe is naturally accompanied by a certain amount of difficulty and prejudice on the part of the consumer, and opposition from those especially interested in resisting the change. The objections which have been raised to steel pipe will be briefly reviewed under the following heads:

Threading.—The greater toughness of the steel caused some difficulty in the trade before the dies were provided with sufficient rake and relief so as to cut more readily. In the days when wrought iron predominated, a die shaped like that in Fig. A. would make a reasonably good thread on iron, but if used on steel would work hard and probably produce a rough thread resulting in a leaky joint. A correctly shaped die is illustrated in the diagram, Fig. B. Considerable economy results from attention to dies, both in time and material, as well as in saving of gas through leakage. The threads should be clean cut, so that the metal-to-metal joint will be gas-tight when screwed up without the aid of some dope. It is easier to make such a joint on steel pipe with proper dies on account of the homogeneity of the metal.

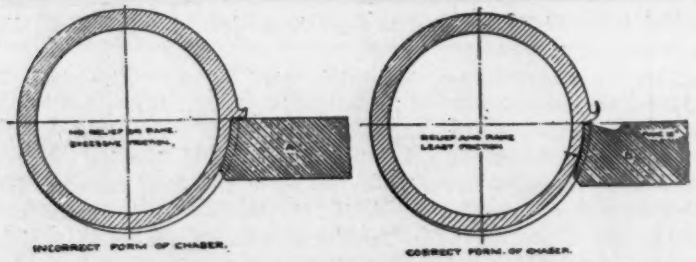


Fig. 1.—Diagram Showing Correct and Incorrect Form of Threading Dies.

Durability.—As to the general impression which prevailed a few years ago that steel was fundamentally more subject to corrosion than wrought iron, it will be worth while for anyone who holds this opinion or has doubts on the subject to carefully examine the basis of his conclusion, or the reports by which he has been influenced. Professor Howe, in a paper before the American Society for Testing Materials, last June, sums up his experience and gives results of tests made in his laboratory and in the field, extending back to 1897. He concludes, from his own tests and all the information which he has been able to procure, and after a thorough study of many comparative tests by others, that there is no important difference in the rate of corrosion between iron and steel used in the manufacture of pipe, but he shows, by a test on steel skelp made 11 years ago, in comparison with one made in 1906, that a decided improvement has been made in the uniformity and freedom from pitting in modern steel pipe. This has been the result of increased experience, and much experimental work, by the leaders in the development of this steel. The influences which tend to make it more durable have been the subject of investigation for some time, and finally resulted in a number of improvements, including a process of working the metal at a soft heat, which gave such promising results as to warrant its adoption in regular practice 2 years ago. Prof. Howe's tests indicate that pipe steel is now equal and probably superior to wrought iron, being less liable to local corrosion or pitting. This conclusion conforms with that of Mr. T. N. Thomson, as the result of personal service tests reported in a paper before the American Society of Heating and Ventilating Engineers, January, 1908, and with our own special tests and numerous service tests, accidental and intentional, which we have investigated as they came to our attention in the regular course of business.

The Pitting of Pipe.—It is now generally believed that corrosion is primarily solution of iron in water. In case oxygen is not present the water soon becomes saturated with iron and corrosion stops with no visible serious results. However, if oxygen is present, the dissolved ferrous iron is oxidized to the ferric or insoluble state, and is precipitated as rust on the metal, allowing more iron to dissolve; thus the process is made continuous. The oxygen seems to have a further important effect, as pointed out by Dr. W. H. Walker, Massachusetts Institute of Technology, in accelerating corrosion by combining with the hydrogen released when iron goes into solution, thereby depolarizing the kathode. Thus, it will be seen that corrosion is a simple electro-chemical phenomena involving an interchange of electricity between two elements between which there is a certain difference in potential, and that this action is kept up through the agency of oxygen; moreover, other conditions being equal, it has been shown that the extent of corrosion is proportional to the available oxygen.[1] Pitting or localized corrosion occurs when the difference of potential between two places on the surface of the iron is maintained in the same direction for a considerable time. This may be caused by variations in composition of the metal, or accidental irregularities on the surface of the iron, due to adhering foreign material, such as mill-scale, rust, carbon, etc. The latter are far more electronegative to iron than the ordinary variations in composition of the metal, and usually determine the location of the pit.

It is the duty of the manufacturer to make a metal which will offer as much resistance as possible to corrosion, but where conditions are favorable the iron will dissolve and return to the form from whence it came, unless these forces are resisted by adequate protection from moisture and air. A paper might better be devoted to the subject of protection. While experience seems to indicate that no universal protective measure can be relied upon, a special study of local conditions will usually suggest the best means of protection. To secure long life in a pipe line, conditions must be favorable or be made so. It is along these lines, by a study of means of protecting iron from air and moisture, that future progress lies. Important experiments to this end under atmospheric conditions are already under way by the Paint Manufacturers' Association, in co-operation with committees of the American Association of Testing Materials. It would be well if similar tests on the protection of buried pipe lines were carried out.

Those especially interested in the manufacture of wrought iron have never proved by comparative tests that the claims they make are borne out in service. They rely on a popular opinion, which direct evidence usually contradicts, and argue that, as wrought iron carries 1½ to 2 per cent. of cinder interlaminated with the iron, corrosion is thereby retarded. This would be reasonable if the cinder were evenly distributed in layers, but a microscopic section of wrought iron will show that the cinder lies in slightly flattened strings, and is so irregularly distributed that loopholes entirely free from cinder are not hard to find. Moreover, it can be demonstrated that the cinder is more strongly electronegative to iron than any other impurity present, and tends to increase corrosion by the local electric currents thus set up.

We have taken considerable time and trouble to investigate every case of failure by corrosion which came to our attention in the last few years, and have found, wherever iron and steel pipe had been together under the same conditions, that while there was generally little to choose between the two, the steel frequently showed decidedly less depth of pitting.

In an investigation of piping on the Isthmian Canal work last spring, in company with the various division engineers, we examined 160 cases where pipe had corroded in service (out of which a dozen were found where steel and iron had been in use) together in the same line, not one of which showed any decided advantage in favor of the wrought iron. Of the others, where no comparison was possible, the life of the pipe appeared to vary from 20 years, and still good, to 1 year, and completely eaten through, according to conditions. The longest-lived samples included both steel and iron, while the worst case last mentioned was a ¾-inch galvanized, wrought iron, water service system of American manufacture.

It is impossible in the limits of this space to get into details on many such cases, but some instances which came to my attention recently, while investigating conditions in the California oil fields, illustrate the character of this evidence. A 3-inch string of tubing, in a water well at the Oregon-Midway Oil Company property, was used for 6 years without perceptible damage. Instead of continuing to pump direct, it was decided to use the air-lift system, and another string of the same tubing was installed, which lasted just 3 months, when nearly every length was found to be perforated at the threads, except the bottom piece, which was entirely eaten through. This piece was pointed out to me as being the worst example of the trouble, and on examination proved to be wrought iron, while the rest of the line was steel. Photographs of these pieces are shown in plate.

Near Lompoc, Cal., some steel casing had been pitted through in places and removed from a well. The corrosion was quite local, and usually affected only one side of the casing. The couplings, which were of forged wrought iron, were found just as badly pitted, and in some cases completely eaten through, although much thicker than the casing proper. (See plate.)

One more instance may be useful as illustrating many cases of the same kind which have come to our notice. A drying kiln in a large cooperage plant was equipped 2 years ago with 1-inch and 1¼-inch steam heating coils. Considerable condensation took place and a few weeks ago the system gave way in a number of places, due to rapid corrosion. Four sample pieces were forwarded to us with the request that in future wrought iron be furnished. Three of these pieces which were perforated, proved to be wrought iron, the other, which was corroded about half-way through, was found to be steel.

My first experiments on this subject were made over 4 years ago in the laboratory, when we suspended pieces of standard pipe materials in hot aerated water. No important difference could be noticed under these conditions, but we were led by this and other considerations to distrust the popular opinion as to the durability of iron, the error of which has been since further demonstated in a more practical manner by abundant evidence like the above.

As to the basis of the general opinion on this question, to which I have referred, at present we can only surmise. Those holding it nowadays for the most part do not distinguish between pipe steel and other grades of steel which do not require such careful attention in manufacture, and probably do not take into account the fact that conditions governing corrosion are much more active to-day than 20 years ago, or that whereas steel pipe has been passing through a period of evolution, and together with other branches of the industry

1. Dr. W. H. Walker.

Fig. 2. Fig. 3.

Fig. 2.—3-Inch Wrought Iron Tube from Water Well, Oregon-Midway Oil Company, California.

Fig. 3.—3-Inch Steel Tube from Water Well, Oregon-Midway Oil Company, Showing the Extent of Corrosion in the Worst Pieces which were Connected Directly above the Wrought Iron Piece Shown in Fig. 2.

NOTE.—A piece has been cut out of Fig. 2 and the steel tube (Fig. 3) which was connected with it, for test purposes.

Fig. 4.—Wrought Iron Coupling from 8¼-inch, 24-Pound Steel Casing, Lompoc, Cal.

is becoming better understood year by-year, the tendency is toward deterioration in wrought iron on account of the passing of the old time puddler and the practice of using steel scrap, often of unsuitable quality, for the sake of economy. Furthermore the properties which distinguish these materials are not generally understood and in many cases their indentity has been mistaken.

Many of the cases of comparative corrosion investigated by us have been on steel and iron pipe, made before any special attention was given to the quality of the steel in resisting corrosion, and this evidence certainly does not lead to any important conclusions one way or the other. Surely, then, it is reasonable to expect that the work already done toward improving pipe steel will produce still more satisfactory results in the future.

Report of Sub-Committee on Calorimetry as Presented to the Third Annual Meeting, The American Gas Institute.

CHAPTER I.—GAS CALORIMETRY.

1. *Practice in America and Europe.*—Ten years ago gas calorimetry in the United States was practically unknown—that is, calorimetry as a general practice in a commercial business—and it has only been recently that a few of the larger gas undertakings have been making the calorific value of the gas a regular test at the works. Probably a half dozen of our larger companies have been making readings systematically or experimentally for some years, but it is only since the State and civic authorities have enacted measures governing the heating value of gas delivered that the calorimeter has been adopted as an instrument to be used daily in our works, and a systematic record made of the heating value of the gas manufactured. In Germany the gas calorimeter has been in more general use, as the authorities and companies there have appreciated the importance of the heating quality of the gas.

The English authorities and supplying companies have demanded spasmodically that the gas be of a certain heating value, but readings have not universally been made in England, although the heating value has been recorded for some time by the larger companies.

The candle power of gas supplied in both Germany and England has been generally lower than in the United States, owing to the fact that the greater percentage of the gas manufactured is coal gas. The tendency bas been in England during the last 4 or 5 years to reduce gradually the illuminating value, as it is known that the heating value is not proportionately lowered; so, while reports of the heating value have not been generally demanded, many of the larger companies have been making and recording calorific readings.

In Germany in some instances the authorities have demanded continuous reports of the calorific value of the gas, and, therefore, readings are systematically made and recorded in many of their cities, occupying an importance equal to, if not exceeding, that of the illuminating value.

2. *Reasons for Increasing Demand for Calorimetry.*—Reports from many of our companies show that from 80 to 90 per cent. of the total gas consumed has been utilized solely for heating purposes, whether used in stoves, ranges or incandescent lighting. This fact has naturally demanded, to a more or less extent, that the heating value of the gas should be given, as well as the illuminating power. We appreciate that in some gases, particularly coal gas, the illuminating value may be reduced without a corresponding reduction in the calorific value, which fact has caused to be embodied in some of our State and civic regulations a demand for the reading of the calorific values.

In industries using producer gas and by-product gases, where the illuminating value of the gas is practically negligible, the sole determination of quality has been the calorific value. The extensive development and use of the gas engine to-day have incited the engine manufacturers to make guarantees upon heating value of the gas, although the constituent gases themselves modify somewhat the serviceability of the gas for engine purposes. If these various industries are determined to measure the calorific value of the gases, it seems important that the gas industry of the country should undertake to determine and describe systematic methods for general use in determining the calorific value of gases. If our State and civic authorities are likewise undertaking to measure the calorific value of urban gas by some method, this method should be universally constant, and should be adopted by the foremost gas association, the American Gas Institute.

3. *Principles of Gas Calorimetry.*—Gas calorimetry may be defined as a process of determining the quantity of heat developed by the complete combustion of a unit volume of gas. The common and most successful method of accomplishing this is through the use of

an instrument known as the "Calorimeter," its auxiliary meters, thermometers, regulators, scales and weighing tanks. An exact quantity of gas can be burned under prescribed conditions and the heat developed in the combustion absorbed by a known weight of water passing through the instrument. It is possible, knowing the weight of the water passed through the instrument and the rise in temperature, to calculate the entire quantity of heat absorbed by the water. This type of instrument is so much the simplest in design and application that your Committee have adhered to it in all their experimental and test work on which this report is based. Other gas calorimeters, designed on different principles intended to measure a part or all the heat developed in the combustion, have been put forward in great variety, but none of them seems to be as easily adapted to our general commercial requirements as those of the water heater type.

4. *English Units.*—The British Thermal Unit is the quantity of heat required to raise 1 pound of water, at its maximum density, 1° F., the maximum density being at a temperature of 39.1°. The amount of heat absorbed by water in being raised 1° at normal operating temperatures, say from 60° to 90° F., is, however, practically the same as when it is at its maximum density, the error being, at 90° F., only .016 per cent., and less at lower temperatures. Therefore, no correction is considered necessary in our operation. The discrepancy would account for a difference of only .096 of a B.T.U. in a 600 B.T.U. gas.

Based on the fact that all gas in this country is sold by the cubic foot, and that the British Thermal Unit has been in general use as expressing the unit of heat; your Committee believe that it is proper to recommend the use of the Fahrenheit thermometer, the cubic foot, and the pound, the results being expressed by direct multiplication in British Thermal Units.

If all our members in future in ordering calorimeter outfits will specify cubic foot meters, Fahrenheit thermometers, scales graduated to one-hundredths of a pound, to weigh the heated water passing from the calorimeter, all the inconvenience of using a mixture of metric and English units, or a reduction of a portion of their data from metric to the English system, will be avoided.

5. *Calorific Value Calculated from Analysis.*—The calorific value of a gas is often expressed as being calculated from analysis. Such an expression may or may not closely approach the value determined by the calorimeter. The analysis of a simple gas containing but few hydrocarbons is easily made, and its heating value easily calculated, but the gas as supplied in our urban distribution is so complex in its character that the determination of its hydrocarbons is a matter of great difficulty, and as these hydrocarbons constitute the important or more compact heating elements, it was necessarily made difficult to accurately calculate the true heating value.

In the hands of the best and most experienced gas analysts, however, we believe that gas analyses can be made to give comparative results and the average composition of the illuminants approximately determined. Nevertheless, before the calculated heating value of a gas is accepted, the accuracy of the analysis should be investigated.

6. *Commercial Calorimetry.*—Commercial calorimetry as usually practiced does not give values which have a scientific accuracy; but, under practical working conditions, results with less than 2 per cent. of error can be easily obtained. By employing extraordinary precautions in calibrating the thermometers, weighing the water, in the adjustment of meter, and in obtaining correspondence between the temperature of the water and that of the room, as well as in making corrections for atmospheric temperatures and pressure, it is possible to obtain an accuracy higher than that necessary for commercial purposes. In the work carried out by this Committee it was found that an accuracy within a fraction of 1 per cent. could be obtained.

For ordinary commercial work the same amount of care need not be taken in the determination. The ordinary wet test meter, familiar to all through its use in photometric work, checked and manipulated in the usual way, is sufficiently accurate.

7. *Factors upon which Accuracy Depends.*—The accuracy of operating depends upon several factors. The instrument should be installed in a well ventilated, light room, free from draughts and vibration, and of normal temperature. The gas should be measured at the temperature of the atmosphere, and the exhaust products should leave the calorimeter as nearly as practicable at this same temperature. With the temperature of gas, inlet water, air and exhaust products the same, there will be no reasons for making corrections for the sensible heat absorbed or lost. The temperature of the water should be practically the temperature of the operating room and should be uniform. With the temperature of the water the same as that of the room, the exhaust products may be made to approach closely to the temperature of the air and gas without difficulty.

In the measurement of water by volume, owing to the large surface exposed and to the irregularities commonly found in the bottom of graduates, it is impossible to read the quantity of water by the eye within a small limit of error. As weighing is not open to these disadvantages, the determination of the quantity by weight largely avoids such errors. The accuracy of the instrument also depends upon the constancy of operation; that is, the rate of flow of gas should be constant, the heat transmitted should be uniform, and, with unvarying temperature of inlet water, there should be no variation in the temperature of outlet water.

Chapter II.—Calorific Value as Related to Heat Utilization

By this we mean the heating value of the gas, as determined by the calorimeter, and the available heat in the gas that is applicable for various uses in the arts. Many misunderstandings have arisen from the use of the words "gross" and "net," as applied to heating values. The gross heating value is that value which is obtained by the calorimeter when the gas, air and exhaust products from the calorimeter are at the same temperature. This condition strikes a thermal balance for the calorimeter, and the heat absorbed by the water passing through the calorimeter is all the heat developed by the combustion of the gas. This result, under normal conditions, is not exact, as the entrained moisture in the air and gas, and the moisture found in the products of combustion, do not balance, but the errors in absorbed heat are slight.

For example, the gas having passed through a wet meter is apt to be saturated. The air may have a saturation of 70 per cent., while the exhaust products leave the instrument saturated. This means that some of the water vapors formed by combustion complete the saturation of the products leaving the instrument. This error is small, and the Committee are of the opinion that, for commercial practice at least, it may be entirely disregarded, as these errors ordinarily in actual practice would be a small fraction of 1 per cent. Hence the calorific value as determined by the calorimeter is the "gross" or true heating value developed by the combustion of the gas. The "net" heating value, so called, is the "gross" heating value, less the latent and sensible heat of the water vapors condensed in the calorimeter. Where there is a large percentage of free or combined hydrogen this condensation is greater, and in certain gases the difference between the "gross" and "net" may be as high as 10 per cent. In other commercial gases it may be as low as from 3 to 5 per cent.; but this latent heat is not lost until the products of combustion leave the apparatus. Under ordinary conditions this might be 130° to 150°, while under some conditions it would be much higher.

Now, if the latent heat and sensible heat of the condensed water from the products of combustion are deducted, there is just as much reason for deducting the sensible heat of the uncondensed portion of the products of combustion, since it is necessarily lost at the same time; and if the temperature of the exhaust products leaving the appliance is very high, this sensible heat may be several times that deducted in obtaining the so-called "net" value. In other words, there would be a different true "net" value for each change in conditions of the utilization of the gas, and none of them determinable by direct test by a calorimeter or any other known instrument. Therefore, the Committee are of the opinion that the heating value of a gas should be expressed only in that which is determinable as the "gross" or total heating value, the value of the gas as given by the calorimeter.

This use of the total heating value of the gas has been objected to seriously by the manufacturers of some appliances, notably of gas engines, as they claim that it is impossible for them to utilize the latent heat of the products of combustion. Their engines exhaust at such high temperatures that the latent heat is never available, and in making guarantees they are inserting clauses whereby the "gross" value, less the latent heat, is considered as the heating value of the gas. If such a condition is to be met, it is only fair, too, that some method should be adopted whereby the "gross" heating value alone is expressed and the available heat for the given purpose is figured in some other way. Gas has become a competitive fuel in many of our industries. All other fuels are rated by their total heating value. Why not gas?

The argument for a correction is based on the claim that all of the heat developed cannot be utilized, but that varies widely with the appliance. With some appliances a great loss is experienced through sensible heat of waste products and latent heat of water vapors.

With other appliances this loss is reduced to very small magnitude and water heaters, or similar types of appliances can be made, as in the calorimeter itself, to utilize it all. In what an absurd position we would find ourselves if, advocating the use of "net" values, we tried to figure the efficiency of such an appliance.

Chapter III.—Calorimeters.

1. *Calorimeters—General.*—The only calorimeters considered by your Committee were of the Junkers, or water-heater type, measuring the gas and determining the calorific power by transferring the heat developed to a known quantity of water, and determining the rise in temperature of this water.

This we think is the only practical type of commercial calorimeter on the market, and at this writing your Committee disapprove of the adoption for commercial practice of any instrument which determines the heating value by raising the temperature of metals, or that records the heating value by measuring the density of liquids, or by which the heating value is deduced from the quantity of air required for combustion.

We also disapprove of the use of calorimeters which do not measure the total heating value of the gas. There have been designed calorimeters that allow the products of combustion to leave at temperatures such that the water vapors formed in the products of combustion will not be condensed in the instrument. This method of operating a calorimeter allows for many chances of error, and it does not provide for measuring the sensible heat that is lost in these products of combustion, and also increases the error occasioned by the presence of moisture in the atmosphere.

2. *Junkers.*—The Junkers' gas calorimeter, designed by Hugo Junkers, of Germany, is probably the best known available instrument. It has been extensively used in the gas works of Germany and England, and to-day is used in the United States by the gas industry, and by users of producer and blast furnace gas. Gas engine manufacturers have depended almost entirely on this instrument for observations to check the guarantees of their engine economies. It was probably the first and most accurate calorimeter to be put into general service, and deserves entirely the credit it has received.

An improvement may be made in this instrument by having the water inlet and outlet on the same level and adjacent, so that the thermometers may be more conveniently observed. The construction of the meter is such that it is impossible to adjust the water level. The entire equipment, to conform to American practice, may be made more convenient if arranged with English units of measurement. The capacity of the Junkers calorimeter is such that it may be used for testing either low or high heating value gas.

3. *Boys.*—The Boys' calorimeter, designed by C.V. Boys, of London, is an instrument which has been adopted by the London Referees for determining the heating value of London gas. This instrument is of limited capacity, and, while it may be made to give very accurate readings with some gases, under certain conditions, it is exceedingly inconvenient in operation. Its construction necessitates taking the calorimeter apart to light or extinguish the burner. The flame adopted is of the illuminating style, and, under certain conditions, with rich gas, is apt to smoke and deposit carbon on the interior of the calorimeter.

4. *Simmance-Abady.*—The Simmance-Abady calorimeter is an English instrument, and is little known to the United States. This instrument is mounted on a platform, which makes its use as a portable instrument inconvenient. There were several difficulties encountered in its manipulation that appeared like defects in the design of the instrument. The outlet water temperature was very difficult to control, and led us to believe that the average reading of the outlet thermometer did not record the average temperature of the overflowing water. The operating directions of this instrument also indicated that fractional revolutions of the drum of the meter should be taken in making observations. The instrument was not provided with a water outlet of constant head. The calorimeter was jacketed with wood, which was found by the Committee to be unsuitable and not as satisfactory for ordinary work as a polished metal jacket.

5. *Sargent.*—The Sargent was the only American calorimeter examined by the Committee. The first instrument tested was found faulty in design and gave irregular readings. A second instrument was submitted by the makers, which gave better comparative readings with the other calorimeters.

This calorimeter embodies arrangements intended to assist in making rapid and accurate observations. The principal point of difference in the Sargent calorimeter is in the adoption of the English units entirely, and of weighing the water instead of measuring it in glass graduates. The instrument is further provided with an automatic electric device that changes the water supply from one measuring vessel to another at fixed revolutions of the meter.

6. *Other Calorimeters.*—No other calorimeters than the above were examined by your Committee, but the various designs as illustrated in our engineering publications were studied carefully, and as they did not embody the simple principles of the water-heater type of calorimeter, it was not thought desirable, owing to the limited time for our work, to make an investigation of these instruments.

Chapter IV.—Tests.

1. *Tests Made by Committee.*—The tests made by your Committee consisted of readings at Philadelphia, further readings at the laboratories of the Milwaukee Gas Light Company, and, finally, of an extended series of readings in the laboratories of the University of Wisconsin, at which special equipment was provided for the purposes of this investigation. The calorimeters were erected and operated according to the instructions of their makers as far as practicable. Changes from the prescribed methods of operation were only made when it became evident that such changes would lead to better results with the given instrument.

They were then operated to determine the capacity of each calorimeter for the absorption of heat. They were further checked to determine the effect of varying quantities of water being raised to different temperatures. They were then checked to see what effect varying the quantity of air supplied to the burner of the calorimeter would have. Further tests were made to determine the actual efficiencies and the rate of combustion at which the maximum efficiency occurred.

2. *The Identity of the Investigators.*—In the investigations of this subject made by your Committee, they were assisted to a great extent by the work and observations made by Messrs. C. O. Bond, Chief Photometrist, Philadelphia (Pa.) Gas Works, at Philadelphia; A. C. Wilke, Chemist, Milwaukee (Wis.) Gas Light Company, and by O. L. Kowalke, Instructor in Department of Chemical Engineering, U. of Wisconsin; R. C. Cornish, Asst. Engineer of the Milwaukee Gas Light Company; and D. A. Powell, Cadet Engineer with Madison (Wis.) Gas and Electric Company, at the University of Wisconsin. These latter men devoted an entire month to the calibration and checking of all instruments used and to the actual tests.

3. *Purpose.*—The purpose of the investigation was to secure information on which to base recommendations to the American Gas Institute as to calorimeters for general commercial practice; also, to determine the accuracy and efficiency of calorimeters in common use, and to formulate and prescribe rules and methods of operating.

4. *Calorimeters Tested.*—1. Standard Junkers' Calorimeter, with pressure regulator, belonging to Chemical Engineering Department, University of Wisconsin.

2. Junkers' Calorimeter, modified so that the inlet and outlet thermometers are at the same height. This instrument has been in daily use for about 1 year and is the property of the Milwaukee Gas Light Company.

3. New Sargent Calorimeter, using wet pressure regulator from a Junkers' outfit and not using the electrical dumping device.

4. Standard Boys' Calorimeter, with wet pressure regulator from a Junkers' outfit.

5. Standard Simmance-Abady Calorimeter.

A few preliminary tests were made at the West Side Works, Milwaukee Gas Light Company, but it was impossible to maintain uniform conditions for more than one calorimeter at a time, on account of small sampling holder and limited water supply. Accordingly, all apparatus was sent to the Chemical Engineering Building, Madison, Wis., where it was possible to maintain a constant water and gas supply for a series of tests.

5. *Calibration of Instruments.*—Before making any tests all thermometers and meters were carefully calibrated. Two standard thermometers were used, one, No. 4,180, belonging to the Chemistry Department of the University of Wisconsin, certified August 9, 1902, and No. 2,620, from the Physics Department of the University of Wisconsin, certified by U. S. Bureau of Standards, January 14, 1908. No. 4,180 has a range from 0 to 100° C., reading $\frac{1}{10}$ of a degree, and No. 2,620 has same range, reading to $\frac{1}{10}$ of a degree. These 2 thermometers were carefully compared through range from 10° to 50°, using a micrometer telescope to read the latter, and an ordinary reading glass, the former. It was found that they did not agree, so the ice point was determined, when No, 2,620 was found correct and No. 4,180 was .08° high. After making this correction, scale readings

were found to agree. As No. 4,180 was more easily read it was used to calibrate the calorimeter thermometers, making the correction for 0 point.

Each calibration was made as follows: The standard and 2 thermometers to be calibrated were suspended side by side in a bucket of water, which was surrounded on the outside with excelsior to prevent radiation. The water was agitated by means of a stirrer operated by a motor. Bulbs of thermometers were immersed to the depth they would be used on calorimeters and correction was made for length of stem exposed. A piece of plate glass was set up in front of thermometers to prevent the observer's breath striking them.

In this way curves were obtained for six of Sargent Steam Meter Company thermometers and two Centigrade thermometers furnished with the M. G. L. Co. Junkers instrument. Copies of these correction curves are shown in appendix.

In order to facilitate our calculations, 4 meters reading to $\frac{1}{10}$ of a cubic foot per revolution were selected. Three of these meters were made by the Sargent Steam Meter Company, and the fourth was an American Meter Company meter, No. 458.

These 4 meters were calibrated at the rate of flow at which they were later used, with a ¼ cubic foot bottle, making 5 complete revolutions of the meter by filling the bottle twice. The calibration of the bottle was carefully checked to deliver ¼ cubic foot of distilled water at 62° F.

All meters were adjusted to within .05 of 1 per cent. After the correct water level was obtained a strip of paper was pasted around the gauge glass to show proper level. Gas was taken from a 5-foot prover and a constant pressure of 14-tenths on inlet of meter main tained. Water for meters and bottle had been previously saturated with gas.

6. *Tests and Comments.*—Water for tests was obtained from a large tank, located above the level of the table on which the instruments were set up. A constant level was maintained in the tank by using a float valve, thereby maintaining a uniform head on the apparatus and supplying water of constant temperature.

Gas tested was run from the city gas mains into 2 holders, each having capacity of about 60 cubic feet. These holders were located in the basement of the Chemical Engineering Building, and were connected in parallel, so that they could be filled and emptied at the same time. The holders were counterweighted to give 2½ inches of pressure, and this was reduced to 15-tenths by means of a governor. No. 1 holder was built with an annular space for the water, thereby cutting down to a minimum the surface of water exposed to the gas. No. 2 holder was built with an open tank and care was taken to use water thoroughly saturated with gas in filling it. No. 1 holder was provided with a fan to agitate the gas. The gas made by the Madison (Wis.) Gas and Electric Company was entirely carburetted water gas. All the apparatus was set up on a bench in a room which could be kept free from draughts. Each calorimeter had its own water and gas connections.

In order to operate the calorimeters under more nearly uniform conditions, some changes were made from the arrangement of apparatus provided by the manufacturers. All meters registered $\frac{1}{10}$ of a cubic foot per revolution. Water was caught in copper tubs and weighed on scales sensitive to ½ gramme in 5 kgs. Float pressure regulators of Junkers' make were used on three instruments and a similar regulator on the Simmance-Abady. All copper tubs were carefully counterbalanced against a lead weight. This was done with the inside of bucket wet, so that no correction would be required during tests. Tubs were filled with water, emptied and then shaken in an inverted position for about 5 seconds.

In setting up the instruments, it was our aim to reduce the number of joints where leakage might occur to a minimum. After apparatus was all connected up, gas pressure was turned on and burner shut off to test for leakage, and no observations made until meter showed no movement. The humidity was determined by means of a wet and-dry bulb thermometer, upon which a constant current of air was impinged by a small motor driven fan. All tests were run in series, and tests of the same series number on different instruments were run at very nearly the same time. A new series was started with each new sample of gas. All tests were recorded on special blanks which were printed for this investigation, and which is shown in the typical calculation. The series of tests as made extended consecutively from A to N.

Series A to F, inclusive, were made with an idea of becoming more familiar with the operation of the several calorimeters, and to find out the effect of varying the gas, water and air supply. Series G and H were made to determine the most efficient rate of combustion of gas in the several calorimeters, maintaining a constant water supply. With the gas used for these tests it was found that for the Boys calorimeter a rate of combustion from 3½ to 4½ cubic feet per hour was the most advantageous; for the Sargent about 5 feet; for the Simmance Abady 4 feet and the Junkers 7 feet. Series I and P were run using these different rates of combustion, and comparative results were obtained. The diagrams (see Appendix E) show graphically these determinations. In these diagrams the time of making the test are plotted as abscissac and the heating value platted as ordinates. Throughout the I series there was a gradual decrease in the heating value of the gas with time. This was possibly due to absorption of some of the illuminants, as the water used to fill the No. 2 holder was taken from one of the holders of the Madison Gas Company, and was saturated with coal gas; whereas, at this time the gas made by the Madison Company was water gas. These series of tests show the relative efficiency of the various calorimeters.

There is a considerable variation in the results obtained on the Simmance-Abady instrument. By referring to the original record sheets of tests made on the Simmance-Abady calorimeter we find an explanation for these widely varying results Take any test at random, say P-1; the temperatures of the outlet water varied from 85.75° to 86.70°. The mercury thread in the outlet thermometer was never steady at any one temperature for even a few seconds, and danced up-and-down over a considerable distance, making it impossible to obtain a fair average, although readings were made as rapidly as they could be recorded, one observing and another recording. Reference to the comments under test "L" shows that with the construction of this Simmance-Abady instrument no reliability of result was obtained.

Comparison of results in series P, between the Junkers and the Simmance-Abady instruments, on gas, shows the Simmance-Abady about 10 per cent. above the Junkers.

Owing to the great fluctuations in the outlet temperature, we are not at all certain that we obtained an actual average of the temperature of the water leaving the instrument. However, based on the two series of tests, one with the electric coil heater and the other on gas, both showing better than 100 per cent. efficiency, we concluded that in its construction, as shown in this instrument, which is about 5 years old, the Simmance-Abady instrument could not be considered satisfactory.

In series J a comparison was made between the U. W. Chem. Engineering Junkers' and the Milwaukee Gas Light Company's modified Junkers'. Both calorimeters were run at approximately the same rate of gas consumption and the same rise in temperature of the outlet water and the same amount of water. A subsequent check on meters used for this test showed that the meter used on the Milwaukee Gas Light Company's Junkers was about .4 per cent. fast. Making this correction on the average reading of this series by the Milwaukee Gas Light Company's Junkers, it leaves a difference of but .4 per cent. between the readings of the two instruments.

7. *Efficiencies.*—The purpose of tests K and L was to determine the efficiency of the absorption of heat in the calorimeter. To determine this efficiency a known quantity of heat energy was supplied electrically for a known interval of time, and the quantity of heat absorbed was determined in the usual way.

The apparatus for supplying this heat energy consisted of a coil of nickel wire wound on a mica frame. The current from a 120-volt storage battery was passed through this coil and measured by standard electrical instruments. The electrical measuring instruments were of the Weston laboratory standard type, and had recently been calibrated. The heating coil was made of 2 pieces of mica, 2 inches wide, 5 inches long and 3/32 inch thick, set at right angles to each other. The frame was mounted on a brass axis, so that it would fit into the ordinary holder for the Bunsen burner of a Junkers' calorimeter. The photograph (see Appendix E) will show details of construction of this coil. The current through the circuit was regulated by means of a lamp bank placed in series in the circuit, and the amount of energy put into the coil was regulated to give a rise in temperature equal to that which had been used in the tests with the gas. In making this test three operators were employed, one to observe the readings of the voltmeter, the second to observe the readings of the ammeter, and the third to operate the calorimeter. The time for each test extended over 3 minutes. During this time readings of voltage and current were taken as rapidly as the observer could record them. Likewise, observations of temperature of inlet and outlet water were taken as rapidly as the data could be recorded. The water passed through the calorimeter during the period of test was carefully

weighed to within 1 gramme, and all results were expressed in small calories. Series of tests of this kind were made on the U. W. Chemical Engineering Junkers and the Simmance-Abady. The results of Series K show an average efficiency of over 99½ per cent.

Series L was made similarly on the Simmance-Abady. The results of this series show that there is something wrong in the construction of this instrument. The efficiency of the instrument shows about 108 per cent. In looking over the temperatures of the outlet water, an explanation for this apparent discrepancy can be found. In this series of tests the observer recorded the observations of temperature as fast as it was possible to do so, and he also attempted to give the extreme variation of such temperature indications. At no time was the temperatare as indicated by the thermometer constant for even a second, but the mercury thread kept moving up and down continually. It would seem that the water as it comes out of the instrument and passes over the dome of the combustion chamber is unevenly heated and not thoroughly mixed to a uniform temperature before reaching the thermometer, and thus the thermometer records not a uniform temperature of water, but water which comes in unevenly heated currents.

Series M was a repetition of the tests of Series J. Before making this series of tests, the two meters were again carefully calibrated. Then the M. G. L. Company's Junkers was run against the U. W. Chemical Engineering Junkers. A series of 5 tests was made with this arrangement. Then another series of 5 tests was made, running the M. G. L. Company's Junkers against a second Junkers, belonging to the University of Wisconsin. These results show a very close agreement between the 3 instruments.

Chapter V.—Specifications and Recommendations.

Your Committee recommend the adoption of a calorimeter of the water heater type. In determining the calorific value of the gas, we recommend the adoption of English units; the measuring of the gas in cubic feet; the correction of the volume of the gas to standard volume, as expressed when measured under a standard temperature of 60° F., and standard barometric pressure of 30 inches of mercury. We recommend taking all temperatures of air, gas and water with Fahrenheit thermometers and expressing the result in Fahrenheit degress.

We recommend weighing the water used with balances readings in pounds and hundredths of a pound.

We recommend expressing the result of all calorific determinations of gas in British Thermal Units, or B.T.U.'s, which is the natural product of a pound degree. As not one of the calorimeter outfits supplied was entirely satisfactory, and as several improvements suggested themselves during the experiments, we consider the following specifications and recommendations necessary for the best results:

1. *Meters.*—For a meter, we recommend one registering $\frac{1}{5}$ cubic foot per revolution. The large dial should be graduated into 100 equal parts, with every 10 parts distinctly marked to facilitate reading. In addition to the large dial, there should be a smaller dial to register the number of revolutions of the large hand. This dial will register 10's, units and 10ths of a cubic foot. The face of the meter should be enameled, and no glass used on the front, thereby reducing the error due to parallax. The face of the meter should be easily removable, in order to get at the shaft and the stuffing box on the shaft. This stuffing box should be of a size large enough to be easily packed. The large hand of the meter should be well pointed and not extend to the outer end of graduations of the meter dial. Several of the meters tested had very wide pointers, and these pointers extended beyond the graduations, so that it was difficult to get accurate readings. The meter should have three leveling screws, two in front and one in the center at the back of the meter. Two level tubes should be securely fastened to the top of the meter, placed at right angles with each other.

The meter should have an outside gauge glass showing the water level. This glass should not be less than ¾-inch, nor more than ¾-inch, inside diameter, as it is necessary to have the glass large enough to be readily cleaned, and small enough that the meniscus formed by the water can be accurately read. The opening through gauge bodies to the meter should be unobstructed, and of a size to correspond with the size of the gauge glass. A pointer to show the correct water level, reading to the bottom of the meniscus, should be put on all water level gauge glasses. For convenience, a standard, 3-light meter union should be used on all meters, and hose nipples for ¾-inch hose should be furnished with the unions. The meter should be provided with an opening for the addition of water when needed. This can be done by using a pet cock with a small funnel mounted on top, connected to the top gauge glass body. An opening must be left for a thermometer in or near the gas outlet. This thermometer should be a chemical thermometer in a metal case, reading to 1° F., with a range of from 50° to 100°, and accurate to within ½°. Some of the thermometers furnished with the apparatus read to 2°, and there were variations on 3 thermometers furnished by one company of 1½°. Another criticism of the same thermometers was that the glass tubing was not round, making the thermometers difficult to read. An opening with a plug connection should be left on the bottom of the meter to drain it when the meter has to be transferred from one place to another. In general, we would say that the number of joints liable to cause leakage should be reduced to a minimum. We found that several of the meters which had faced joints were very difficult to keep tight, even by using carefully made gaskets.

2. *Regulator.*—The pressure of the gas when burning in the calorimeter should be absolutely uniform, to obtain the best results, and any small regulator that will maintain this uniform pressure will be satisfactory. We recommend the use of a small, wet governor, as supplied with Junkers' calorimeter, as giving excellent regulation, and which will operate without chattering. Such a regulator should be constructed so as to be readily weighted for altering the pressure.

3. *Calorimeter.*—The calorimeter should be designed to give a constant head of water on the apparatus. This head can be maintained by having a weir-overflow on the inlet at some distance above the top of the calorimeter, and a weir-overflow on the outlet. The rate of flow through the apparatus should be regulated by means of a cock on the inlet water. It was necessary, in case of the Boys' calorimeter, to use a screw cock on the rubber tubing to get variations in the rate of flow. This was not used on this calorimeter, except during very low consumption of gas, as at higher consumption the coil was not large enough to give an amount of water capable of reducing the temperature to the desired range.

A calorimeter should be so built that the water will circulate freely and that there will be equal distribution of water throughout the apparatus. Baffle-plates should be so arranged that the water will be thoroughly mixed before coming in contact with the bulb of the outlet thermometer, thereby giving correct readings. The design should be such that air pockets will not form in the water space. It was found in several tests that considerable variations in temperature arose from neglect in this particular.

The calorimeter should be made of bright, polished metal, air jacketed in all its parts. We found a reduction in heating value by one of the calorimeters on spilling water over the wooden jacket, due to evaporation of water from the jacket, and since the accidental wetting of the jacket is always liable to occur, we consider the use of an absorbent jacket a serious defect in design. There should be a damper in the exhaust gas flue which can be easily adjusted and which will not be moved by a slight jar. The calorimeter should be mounted on 4 legs, with a spread great enough to give a firm base, at a height sufficient to make it easy to put the burner in place.

Thermometers should both be on the same level to facilitate readings. This is a desirable feature of the Sargent, and there is no reason why Junkers instruments made in the future should not conform to it. The openings for thermometer corks should be large enough to take a No. 4 rubber stopper.

4. *Burners.*—The Boys' calorimeter was provided with a burner with an illuminating flame, and while this was found satisfactory for small gas consumption, it was replaced with a Bunsen flame, which was equally satisfactory under all of the same conditions, and in addition had a wider range for the rate of flow. The burners provided with the other instruments tested were solely of the Bunsen type, which is the type that we recommend for general use. The burner should be a long-tube Bunsen, having a spreader on top, an adjustable air mixer which can be easily reached when burner is in position in the calorimeter. The burner should be provided with a stopcock to change the regulation. The burner should be attached to the calorimeter in such a way that its position cannot be accidentally shifted, and also so that the condition of the flame may be observed by the operator, either directly or by means of a reflecting mirror.

5. *Thermometers.*—Accurate thermometers are the most important accessories to good calorimetry. In supplying many of the thermometers with calorimeters up to the present time, cost has apparently had a large influence, and some very poor thermometers have been supplied with commercial calorimeters.

Your Committee believe that the thermometers (particularly those for reading water temperatures) are one of the most important ad

juncts, and should be of such a quality as to read accurately within $\frac{1}{10}$° F.

The thermometers should be graduated from 60° to 110° F., each degree to be divided into 10ths, with short, distinct graduations. The thermometer should be accurately made, so that in ordinary commercial work corrections may be neglected. With each thermometer should be provided a calibration curve, which would enable very accurate results to be obtained whenever it was deemed necessary to make these corrections. Thermometer cases should not be more than ½ inch in diameter and be made of thin glass. This will prevent reflection and parallax in reading. The bore of the thermometer tubing must be carefully made, as it was found that of 6 thermometers of one make, compared with a standard thermometer, there was a considerable minus correction in the lower portion of the scale, and a very abrupt plus correction in the upper part of the scale. Telescopic sights for reading of thermometers should be provided, as much more accurate readings can be obtained in this way. Where disputes arise as to results, we recommend the certification of thermometers by the United States Bureau of Standards at Washington. They are prepared to do this work promptly and at a reasonable expense.

6. *Barometer.*—Corrections for variation in barometer readings should be made in measuring the volume of the gas. These readings should either be made by means of a mercury column barometer or by a recently calibrated aneroid barometer. Where it is possible, barometer readings should be checked occasionally with readings of the Government Weather Bureau of the city in which the readings are made. It is possible to get fairly accurate readings where no barometer is available by obtaining from the Weather Bureau the barometer readings for the day.

7. *Water Supply and Measurement.*—The control of the temperature of the water supply is a very important adjunct to accurate calorimetry, and this temperature should be approximately the temperature of the room or atmosphere in which the observations are being made. Water obtained from an ordinary house piping system is apt to be variable in pressure, and also very variable in temperature, due to the uneven consumption in other parts of the building, and possible exposure of the water main to the extreme temperatures of the ground or atmosphere. This control of temperature and pressure may be readily obtained by providing a permanent water supply tank in the upper part of the room or building that will contain enough water to enable the readings for the day to be made. A flat tank of large horizontal area is preferable to a deep vertical tank. The exposed surface allows the water to come to the temperature of the room more readily, while the shallow depth affects the head less as the water is being used.

Water may be collected and weighed in thin sheet metal containers, holding about 8 pounds of water. This size container will hold all the water required in burning .2 of a cubic foot of ordinary illuminating gas with a range of about 15° in temperature between the inlet and outlet water. The scales, or balance, employed should have a capacity of about 10 pounds, should read to $\frac{1}{10}$ of a pound, and should be calibrated and certified to as being correct by proper authorities.

8. *Gas Piping and Tubing.*—The piping for a calorimeter should consist of as much metallic piping as possible, and the lengths of rubber tubing used in conducting the gas should be as short as possible, and when used should be saturated with the benzine vapors and other illuminants. The absorption of the illuminants by the tubing, however, has less effect upon the calorific readings than it has upon the photometric readings.

9. *Humidity.*—It may be desirable to have the state of the humidity of the atmosphere during the test, in which case percentage readings may be made from wet-and-dry bulb thermometers. For accurate work these wet-and-dry bulb thermometers should be arranged so that the average humidity of the room may be obtained. This may be done by having a whirling wet thermometer, or having a constant current of air impinging upon the wet bulb from an electric fan; or, a more perfect instrument in the form of an Assman psychrometer may be obtained. The percentage of saturation of the gas itself may be obtained by readings made with a gas hygrometer. These humidity readings of the gas and atmosphere are not necessary in commercial calorimetry, but may be found useful if it is desired to make corrections for heat absorbed or evolved in saturating the products of combustion.

10. *Remarks and Criticisms Concerning Specific Instruments Based on Experience During Tests—The Junkers.*—The design of this instrument is such that it is jacketed by a polished metal surface, containing an air chamber. This has proved by experience to practically prevent radiation. The water circulates but once through the instrument from bottom to top, and opposite in direction, as it should be, to the products of combustion. The water content is comparatively small, about 1½ pounds, but large enough for the efficient absorption of all heat through a wide range of gas consumption, and ample to enable gas of greatly varying heating values to be readily measured. The small, fixed weir for maintaining a constant head of water on the calorimeter, and the controlling cock with a quadrant arm for indicating its position, are admirable and necessary for the best work. The overflow is so arranged that siphoning is impossible. When not in use the instrument is easily drained of its water content. The location of the thermometers gives accurate readings of the average temperature of both the inlet and outlet water.

One objection to Junkers' calorimeter is that the thermometers are not on the same level, which makes rapid readings awkward and inconvenient. The instrument as now mounted on 3 legs is somewhat unstable, and it is rather difficult to insert the lighted burner when the instrument is set up. The gas meter supplied with the Junkers' calorimeter was open to serious objection. It has an inside, fixed, overflow, which cannot be adjusted when out-of-proof, and a meter which cannot be adjusted is certainly unfit for this service. The interior of the calorimeter allowed for draining the condensate as well as any instrument tested. The supply of air through the calorimeter could be readily regulated by the damper in the waste products flue, a convenient and necessary arrangement for efficient work. The workmanship on the entire Junkers' calorimeter was good and commendable.

The Simmance-Abady.—The Simmance-Abady is mounted on a large, cumbersome stand, and is not convenient as a portable instrument. It is jacketed with wood, which is not considered as serviceable as polished metal. The water content is large, being 12½ pounds, which necessarily takes a longer time to strike a thermal balance, and renders short readings more liable to error. This is in direct contradiction to the claims for the instrument, which were that the calorimeter could be used for quick readings, the dial of the meter being divided so that fractional revolutions of the drum should be taken. This is another objection, and is in opposition to careful and accurate work.

The circulation of water through the Simmance-Abady calorimeter does not seem to be such that the heat is absorbed from the waste products of the gas with any uniformity. The water courses up-and-down through the instrument several times, while the gases go through once. This causes an uneven heating, which is augmented by the construction of the last water-pocket above the combustion chamber. This arrangement made the outlet water temperature very difficult to control, and led us to believe the average reading of the outlet thermometer did not record the average temperature of the outflowing water. The water inlet pressure was designed to be controlled by a water gauge, instead of the usual weir-overflow. The outlet was controlled by a 3-way cock. The waste from this cock caused a siphoning effect in the calorimeter and altered the head of water through the instrument. The shifting device for operating the water in the outlet was not adapted to our use, and it was necessary to remove it and support the overflow from a stand to get a more constant head.

The Boys.—The Boys' calorimeter was found to be unsatisfactory for American practice, it being too inconvenient to operate and of too limited capacity. The water content was only about .7 of a pound, which limited the rate flow of gas capable of being burned, and eliminated the use of this calorimeter for our richer gases. This calorimeter is quite different in construction from the other types tested. It is in two parts, the lower base and burner being mounted together, while the water coil and envelop are fastened together and easily removable by simply lifting from the base. The water courses through the calorimeter in double-coiled pipe, ending in a baffling compartment over the combustion chamber. The use of an illuminating flame in the Boys was open to some objections. It would smoke if turned too high, or used with a rich gas, thereby causing a deposit of carbon on the water coils, decreasing the efficiency. A Bunsen burner was substituted by your Committee, which gave more satisfactory results and increased the capacity of the calorimeter. The illuminating flame was selected by the designers because its reflected light could be seen through the opening above the base, showing the operator that it was still lighted. Better facilities should have been provided for this purpose.

There was no way of regulating the supply of air through the calorimeter, either by burner adjustment or dampers. In case any adjustments have to be made on the burner or on the rest of the apparatus, it is necessary to lift off the heavy coil and place it on some sort of a support arranged nearby, as it cannot be moved far without disturbing water connections. If the test were made according to the instructions of the London Referees it would be necessary to lift out the coil and shut off water in order to make more than one run, as the shifting device for throwing the water in the glass graduate is mounted directly on the graduate. While testing we avoided this by supporting this shifting device by means of a clamp, and maintained a constant head on the apparatus by supporting an overflow from another clamp above the shifting device. In this way we were able to make a number of successive tests, and could vary the rate of water and gas supply to the apparatus without lifting off the coil.

In the Boys' calorimeter the inlet and outlet thermometer openings are not large eneugh to use even a No. 3 rubber stopper, and the connections are so short that a stopper which has been firmly placed in the connection will extend down far enough to throttle the flow of water, or even a thermometer with a large bulb will throttle the flow.

The pressure regulator furnished with the Boys' instrument is complicated and has a large number of joints which are difficult to get tight. We had so much trouble with this regulator that we finally abandoned it and used a regulator from a Junkers' instrument.

The meter furnished with the Boy's instrument registered $\frac{1}{10}$ cubic foot per revolution, and the large dial was divided into 100 equal parts. To facilitate calculations, this meter was not used. The water line on the meter is shown by an outside gauge. The gauge is so large that accurate readings are difficult.

The Sargent.—The Sargent calorimeter is wood jacketed, an objection, as stated before. The water content of the first instrument is almost 12 pounds, too large for general purposes, although if the operator has sufficient time at his disposal accurate readings may be made with a calorimeter of this capacity, but slight fluctuations in the quality of the gas are less likely to be caught. The course of the water, as in the Simmance-Abady, is up and down the calorimeter 3 times, while the gas products pass through in a single course. We understand this has been improved and a single circulation of water substituted. The thermometers on this instrument are on the same level, which enables the temperature of both inlet and outlet water to be conveniently read. The air supply is easily regulated by a damper in exhaust flue. An ingenious device, enabling the water to be turned on-and-off the measuring tub, was supplied with this calorimeter. This device is operated electrically by contacts on the gas meter hand. Arrangement is made for weighing the water with scales indicating pounds and hundredths of a pound. A diaphragm regulator was mounted on the meter, but, owing to leakage through the leather, and a slight chattering, this was not used, but a wet governor substituted.

The Sargent meter is of the wet type, with drum $\frac{1}{10}$ of a cubic foot per revolution, the dial being divided into hundredths of a foot. The meter has the outside gauge glass, but the lower part of the glass is obstructed by a screw, which was designed to show the proper height of water. This screw has a large, flat head, which interfered by holding the water down by a capillary action, so that the correct level of the water in the meter was not determinable.

11. *Selection of Calorimeter.*—The calorimeter selected should be an instrument that is portable, conveniently handled and easily adjusted, and one that will give results that may be transcribed to English units with the least difficulty. It should have sufficient heating surface to transmit to the water all the heat developed by the combustion of the gas at the desired rate. The course of the water should be direct through the calorimeter and oppose the flow of the products of combustion. This will tend to prevent any irregular heating of the water column and should give uniform temperatures passing the outlet thermometer.

The exterior surface of the calorimeter should be of such a nature that the radiation from it and the adherence of dust and fumes to it shall be a minimum. Preferably a polished metal exterior. The inlet and outlet thermometers should be located at about the same level and close together. The water connections to the calorimeter, especially at the points of location of the thermometers, should be so arranged and constructed that there is no possibility of heat being transferred or conducted from the outlet water to the inlet water, and thus affect the true temperature readings. The auxiliary apparatus should follow in general the recommendations and suggestions made in the earlier paragraphs of this chapter.

12. *Instructions for Operating a Calorimeter.*—The calorimeter should be set up in a quiet, light and well ventilated room, which is free from draughts and in which the temperature can be maintained constant between 60° and 80° F. The room should be provided with a bench and sink and with a good supply of running water. It is advisable to have a large, shallow, open tank suspended from the ceiling, from which the water supply can be taken. This tank should be large enough to supply the calorimeter for a series of a dozen or more tests. By having the tank shallow the water is brought more quickly to the temperature of the room. In order to take care of the difference in head as the tank is emptied, it is advisable to have a weir overflow on the outlet. If only a single test is desired, gas may be taken from the house piping; but if average value is required, a small holder or averaging tank should be set up and the gas flowing into holder adjusted to just fill it in the time during which the sample is to be taken. Care should be taken to have the service from which this holder is filled short and of small piping, in order that average sample may be obtained, or that the sample be taken from a line on which there is considerable consumption. On unpacking the apparatus, see that it is clean and free from packing material.

Set up the calorimeter so that the overflow and outlet water can be easily led lo the sink. Make water connections with rubber tubing, being careful not to cramp the tubing. To avoid air currents, caused by the movement of the observer's body, set up the calorimeter so that the water supply may be easily adjusted and that all temperatures may be readily observed. Lead the outlet water to a funnel a little above the top of the copper container used in collecting the water, so that the water can be shifted from the funnel to the container without spilling. Set up meter facing the observer and level it carefully. Fill it with water slightly above the level mark on gauge glass. Connect inlet of meter to gas supply with rubber tubing. Fill pressure regulator with water, then connect it with outlet of meter, and from outlet of pressure regulator to calorimeter burner. All rubber tubing used to connect meter, pressure regulator and burner should be as short as possible.

When fresh water or new gas tubing is used for the first time, gas should be passed through meter and all gas connections for 1 or 2 hours before test is made. This is necessary to insure saturation of water and tubing with gas.

Turn on gas and allow it to burn for 5 or 10 minutes. Shut off gas at burner and watch hand on meter for leakage. Be sure that all leaks are stopped before attempting to make a test. Shut off gas, remove pressure and draw off water from the meter until it is exactly at the point shown by gauge. Start water running through the calorimeter, light burner and insert it in the calorimeter; then regulate the burner to burn at the rate of 4 to 7 feet an hour, as may be found by experiment to give the highest result with the gas to be tested, admitting enough air so that the flame shows a faint, luminous tip. Water should be regulated so that there is a difference between the inlet and outlet temperatures of about 15° F. The temperature of the inlet water should vary but little if an overhead tank is used and no water added during the test. Before making the test the barometer, temperature of the gas at the meter, temperature of room and temperature of waste gas should be recorded. It is desirable to have the temperature of the inlet water and temperature of waste gases as nearly as possible at room temperature, in order to establish more nearly a thermal balance.

Next allow gas to burn in the calorimeter for a period of from 20 to 30 minutes. The test may now be started by shifting the outlet water from the funnel to the container just as the large hand on the meter passes the zero point. Readings are then made of inlet and outlet thermometers, making the readings as rapidly as the observer is able to record them during the consumption of 2-tenths of a cubic foot of gas. At least 10 readings should be made. Water is again shifted from the container to funnel as the hand passes the zero point the second time. Water is then weighed. The uncorrected heating value per cubic foot is obtained by multiplying the difference of the averages of inlet and outlet temperatures, by the number of pounds of water, and dividing by 2-tenths. This quantity is divided by the correction factor for barometer and temperature, obtainable from tables, to give the heating value at 30 inches pressure and 60° F. The weight of container should be obtained while the inside is wet. This may be done by filling it with water, emptying and shaking for about 5 seconds in an inverted position. This will do away with any correction where several consecutive tests are required with same container.

13. *Care of Instruments.*—The calorimeter being a delicate and sensitive instrument should be very carefully cared for when not in

use. If the instrument is set up permanently provision should be made that it be not disturbed by anybody except the operator. If the instrument is not erected permanently, when dismantled it should be carefully cleaned inside and out and the thermometers removed and carefully packed in cotton. It seems hardly necessary that instruction should be given for the care of such an instrument, but certain precautions should be noted.

14. *Capacity or Intelligence of Operator.*—Any chemist or young man who is capable of making close observations of thermometers and meter readings should be a successful operator for commercial observations.

15. *Precautions: "Don'ts."*—Don't place lighted burner in calorimeter when hot water is not running through it.

Don't shut off water while gas is burning, and if water is accidentally shut off, shut off the gas quickly to avoid breaking thermometers.

Don't move suddenly near the instrument during test. Slight draughts thus caused will vary outlet readings and vitiate test.

Don't forget to test meter and all connections frequently for leakages.

Don't make the test with inlet water below temperature of room.

Don't erect the calorimeter too close to any heating or lighting appliance, where radiant heat might affect the readings.

16. *Typical Calculation (Example).*

O O

Test Record *Milwaukee-Junker* Calorimeter. No. *J*-1.
Date *July* 9, 1908, 3 P.M.
Barometer 29.26. Temperature of Gas 72.68.
Correction Factor 0.9423.
Humidity 66 per cent.
Room Temperature 72.6. Exhaust Temperature 75.2.
Condensed Water Collected per cubic feet gas.
Time one Rev. Meter 52 *Sec.* = 6.92 cubic feet per Hour.
Gas Consumed During Test 0.2 cubic feet.
Weight Water Heated 7.5728 *lbs.*

Temperatures				
Ther. No. *U.W.* Inlet. *IIII.*		Ther. No. *U.W.* Outlet, *III.*	
1.	72.91		88.03
2.	72.91		88.00
3.	72.91		88.00
4.	72.91		87.97
5.	72.91		88.00
6.	72.91		88.00
7.	72.91		88.01
8.	72 91		87.97
9.	72.91		87.97
10.	72.91		88.00
Av.	72.91		87.995
Cor.	−0.174		+ 0.100
	72.736		88.095

15.359
7.5728
122872
30718
107513
76795
107513
0.2(116.3106352
0.9423)581.553176(617.16
56538
16173
9423
67501
65961
15407
9423
5984

Rise in Temperature 15.359
B. T. U. 617.16
Remarks *R. C. C.* Observer.

17. *Use of Computer.*—The labor of making the calculations for determining the heating value from observations of a calorimeter may be lessened by the use of a heating value computer, which has been designed by one of the members of the Committee. The computer consists of a circular slide rule, with divisions corresponding to the readings made on the calorimeter. This computer gives the corrected heating value of a cubic foot of gas in B.T.U.'s, having the barometer and temperature of the metered gas, and the difference in temperature between the inlet and outlet water and the pounds of water passed. This computer is designed to operate within the limits recommended by the Committee, and will give corrected heating value of the gas of from 300 to 800 B.T.U.'s. Should a gas of a lower or higher heating value than 300 to 800 B.T.U.'s be measured, the computer can still be used by dividing or multiplying one of the other factors in its computation.

18. *Suggestions for Further Investigation.*—Your Committee, knowing that much could be learned by further investigation of the subject of calorimetry, suggests the following topics, not with the idea that their investigation is necessary as an adjunct to commercial calorimetry as at present practiced, but as a means of further enlightenment on the general subject as affecting close and scientific determinations:

Effect on calorific readings resulting from a varying atmospheric humidity. Effect on heating value resulting from a difference in temperature between the inlet water and room atmosphere. Determination of heat lost through the products of combustion leaving the calorimeter above or below the atmospheric temperature.

Chapter VI.—Single Standard of Gas Valuation.

It has long been known by those having to do with the regulations governing the quality of gas to be supplied to the public, that the candle power required for certain kinds of gas has been much greater than that required for certain other gases. The difficulty of accurately expressing the utility value of the gas by candle power has been generally recognized by the more careful investigators, municipal and State, endeavoring to do the regulating, and by gas engineers whose work is vitally affected by this regulation. Therefore, it seems pertinent that some step should be taken whereby the product supplied could be more equitably compared and more readily referred to some serviceable standard or unit. This is particularly true under the present practice of supplying a mixture of several kinds of gas in varying proportions. It is also true because of the great strides which have been made in the production of more efficient apparatus for the transformation of the heating value of gas into light, that the relative value of flame luminosity and candle power has become less.

The proportion of gas actually used for purposes, where its candle power is of prime importance, is quite small, and becoming smaller. For all other purposes, such as heating, power, lighting by use of the incandescent mantle and similar devices, the heating value is clearly and beyond argument the simplest, clearest and the most satisfactory method of commercially valuing the gas. This being so, the question has been raised in the minds of many as to whether we were not unnecessarily encumbering our regulations; whether we were not adding unnecessary complications to our testing and hampering the best commercial development of our gas works and gas making processes by the use of a double standard.

The investigations of this Committee, we believe, would go to show that the heating value can be easily and definitely determined, that the process of making this determination is a comparatively simple one, and that with proper instruments the personal error is small; that, therefore, this method of testing the value of a given gas is decidedly preferable to the photometric method, for the reasons expressed above.

We, therefore, respectfully submit the question for the careful consideration of the Institute, and suggest that it be passed on to next year's Technical Committee for further study, looking to a definite recommendation to the Institute at the 1909 meeting.

In this connection, we would call to your attention the pioneer work in this direction, which has been done by the experts of the Wisconsin State Railway Commission, which has tentatively established standards for the State of Wisconsin calling for a single standard of value, the single standard adopted being the calorific value in terms of the entire, or so-called, "gross" heating value, expressed in British Thermal Units. Respectfully submitted,

R. B. Brown, Chairman,
C. F. Burgess,
J. B. Klumpp,
} Sub-Committee.

(To be Continued.)

The Financial Problems of the Manager.

[Communicated by Mr. Frank T. Hulswit, President of Child, Hulswit & Company, on the occasion of the Grand Rapids Convention of the lighting properties operated by that Company.]

When the management of this convention assigned to me the subject of "The Financial Problems of the Manager," I felt greatly honored to be allowed to express some ideas on this most important subject, but after listening to the very able papers of last evening and to-night, I realize strongly my weakness along oratorical lines and I crave your pardon if, in some of my remarks, I am not as eloquent as the preceding gentlemen. I hope that I may drop some hints and ideas which may be used to particular advantage by those present, and suggesting a very frank criticism of anything that is said, in order that I may gain by the valuable ideas which no doubt all of you can bring to bear on the subject.

Let us take, before entering into the actual discussion of the subject, a look backward, to October 1, 1904. On that date, Child, Hulswit & Co. started in business, in one small room, with Mr. Child and

myself as officers, bookkeepers and stenographers – with a great deal of confidence and a small amount of cash.

We have steadily grown, until to-day we occupy a creditable suite of rooms in the best office building in the city, and our payroll now covers 12 people. From the acquiring of the Cheboygan (Mich.) Gas Light Company, with a bonded and stock capital of $150,000, we have grown until to-day the total bonded and stock capital of the properties under our management exceeds $5,500,000. Our properties to-day pay out annually for interest, dividends and sinking funds, nearly $200,000. We pay in taxes in excess of $25,000.

Starting with a total investment in the Cheboygan Gas Light Company, of $50,000 of property, a most conservative valuation of the replacement value of the plants to-day, would be about $3,250,000.

It is needless to say that the "Home Office" keenly feels the immense responsibility to its friends and investors, who have entrusted this organization with so large a trust and responsibility, and if I do not accomplish more to-night than to impress upon you men your great share of the burden of the handling of the property of which you are directly in charge, I will feel that my effort has not been in vain.

It is of immense importance that each of you realizes to the fullest extent the sacredness of the trust reposed in him; primarily by the "Home Office," but more especially by the bond and stockholders who have entrusted you with the handling of a portion of their means. It is essential to success that there exist a spirit of absolute co-operation with the "Home Office," and a perfect understanding of all questions that may arise. The central organization, through its influence and friends, can be of large assistance to you in the handling of your finances, but only so far as you are absolutely frank in stating your financial requirements, backed up by arguments that are convincing, which call for expenditures that you have demonstrated will produce results.

There is a tendency, when crowded by neighborhood public opinion, to recommend to the "Home Office" expenditures for extensions of mains and services, which on the face will not show financial returns warranting the placing of these extensions. And while there is a general order governing this work, we do not wish you to feel that this order is an ironclad one, which, if a peculiar circumstance arises, does not warrant you to give us good reasons for making such extensions; for, in some instances, valuable business might be lost to competitors if the extension were not made at the proper moment. I simply wish to emphasize, however, that no money must be spent along these lines—or for that matter, along any other lines—that after a most careful study does not show a financial return larger than the interest on the money required to be used to make the expenditure. I also wish to call your attention, and caution you, to most carefully scrutinize your estimate of expenditures sent in to this office, for two reasons:

First. If your estimate of expenditure was too low, and it is O.K.'d, and you proceed with the work and find, upon completion, that you have spent more than was authorized, you put yourself in the position of exercising poor judgment in the situation.

Second. If you place your estimate of proposed expenditure too high—in fact, puposely so, in order to show that you were able to effect the completion of the work for less than called for, thereby hoping to get credit as a painstaking and saving manager—you run the risk of having the expenditure turned down by the "Home Office" because it looks too high.

A point I wish to impress you with very strongly is the question of the size of the stocks of merchandise you carry for sale, such as fixtures, arc lamps, stoves, etc. If we have made mistakes in the past, one mistake was that of carrying too large a stock of supplies of this nature, which was not warranted by local conditions, thereby tying up considerable money on which interest, at the rate of 6 per cent. was paid, burdening the plant with the additional fixed charge. I would urge upon you all most strongly, the having on hand of modest stocks of this nature, keeping them clean and up-to-date, and using every effort to clean up the stocks of supplies you now have on hand to convert into cash.

Of the utmost importance in the mind of every conservative business man is the point of the discounting of bills. When a corporation has the reputation of taking advantage of every possible discount, and promptly meeting its bills when due, it establishes a reputation for business dealing far in advance of its neighbor, who may be financially just as strong, but is lax in taking care of this important item.

Nothing else is so necessary to credit as confidence, and nothing else is so necessary in business like ours as credit. You will be able to do a comparatively large business on conservative lines if you have a well established credit, and you will find the banker very willing to loan you money at reasonable rates when this has once been proved and kept good. However, the banker is easily scared, and if you come to him with repeated promises which you do not fulfill, he is very liable to mistrust your financial situation, and be inclined to call your indebtedness to him at most inconvenient times to yourself, or refuse to extend you credit when you need it. It is of the utmost importance that when you promise to pay a trade debt, or a note to a bank or an individual, that you make this promise good, and pay the debt on the date it falls due, or arrange in advance for a satisfactory extension of time. It is far better not to make promises than to make them and break them; and an individual or corporation following the latter practice soon finds its word of little value and its credit lightly regarded.

When you arrange with your banker for a loan, be frank with him and tell him what you want it for, if he asks for the information; but do not tell your troubles to him—he is not likely to be interested, and is in no position to solve them. He expects you to do that. Tell your troubles, if any, to the "Home Office."

Another point which I wish to call to your attention, and one that probably appeals stronger to the "Home Office" than to you as individual managers, is the question of setting aside each month in cash, the monthly pro rata of the total interest, taxes and dividends which are fixed charges on your property, drawing on this account only for the actual payment of such items. It is my earnest desire that we may work out, in the very near future, a plan by which every Company that we control makes a business practice of doing this. This will probably appeal to some of you as a hardship, but I sincerely feel that, if we once accustom ourselves to this practice, and plan our finances accordingly, we will never again wish to do it differently.

Wherever you have local directors who are interested in the Company, be sure to call on these men occasionally and give them an idea of what you are doing, and asking their advice on business matters. The average business man is willing to help and appreciates a younger man coming to him for suggestions – you are sure to win in this manner his co-operation and esteem.

Be sure that we at Grand Rapids will appreciate suggestions from you in reference to finances and will welcome them at all times. You may see where beneficial results to your Company can be obtained by the placing locally, in your several cities, bonds and stocks of the Companies in which you are most directly interested; and you can doubtless be of a great deal of service to your own Company and to Child, Hulswit & Co., in this way.

The Denver Gas Company has very successfully followed the practice of placing small blocks of its securities locally in the hands of small investors, and has in this manner enlisted in promoting its welfare a large number of financially interested citizens, who are sure to stand it in good stead, should there be any local agitation as to reduction of prices or harmful legislation toward the Company. It will be of a great deal of interest to us in the near future to work out some similar plan which we can use to good advantage in the communities where we are interested.

Two very important points in the management of any business that that has a product to sell are: To sell it at the right price and collect for what you have sold.

The last point becomes a very simple matter in the business in which we are all interested, due to the fact that we can, at our discretion, shut off a further supply of light or fuel if prompt payment is not made; and I personally consider it a very poor excuse to be told that the reason for a large amount of uncollected gas, coke and appliance bills is the fact that the collector cannot get the money. You should be reasonably sure in selling any product of your Company, that the purchaser or consumer is one who meets his bills promptly; and if this precaution is taken (in cases where you cannot, a deposit is demanded) uncollectible bills will become a negligible factor in your plant.

Reviewing this brief paper, I hope I have impressed upon you, as I have tried to do, that a manager must be more than a mechanical man; that he must be more than an office man; that he must also be in every essential a business man in the largest sense of the word; for he has problems which a business man, not engaged in manufacture, does not have to meet.

The financial and the operating departments are absolutely inter-

use. If the instrument is set up permanently provision should be made that it be not disturbed by anybody except the operator. If the instrument is not erected permanently, when dismantled it should be carefully cleaned inside and out and the thermometers removed and carefully packed in cotton. It seems hardly necessary that instruction should be given for the care of such an instrument, but certain precautions should be noted.

14. *Capacity or Intelligence of Operator.*—Any chemist or young man who is capable of making close observations of thermometers and meter readings should be a successful operator for commercial observations.

15. *Precautions: "Don'ts."*—Don't place lighted burner in calorimeter when hot water is not running through it.

Don't shut off water while gas is burning, and if water is accidentally shut off, shut off the gas quickly to avoid breaking thermometers.

Don't move suddenly near the instrument during test. Slight draughts thus caused will vary outlet readings and vitiate test.

Don't forget to test meter and all connections frequently for leakages.

Don't make the test with inlet water below temperature of room.

Don't erect the calorimeter too close to any heating or lighting appliance, where radiant heat might affect the readings.

16. *Typical Calculation* (*Example*).

O O

Test Record *Milwaukee-Junker* Calorimeter. No. *J*-1.
Date *July* 9, 1908, 3 P.M.
Barometer 29.26. Temperature of Gas 72.68.
Correction Factor 0.9423.
Humidity 66 per cent.
Room Temperature 72.6. Exhaust Temperature 75.2.
Condensed Water Collected per cubic feet gas.
Time one Rev. Meter 52 *Sec.* = 6.92 cubic feet per Hour.
Gas Consumed During Test 0.2 cubic feet.
Weight Water Heated 7.5728 *lbs.*

Temperatures			
	Ther. No. *U.W.* Inlet. *IIII.*	Ther. No. *U.W.* Outlet, *III.*	
1.	72.91	88.03	
2.	72.91	88.00	
3.	72.91	88.00	
4.	72.91	87.97	
5.	72.91	88.00	
6.	72.91	88.00	
7.	72.91	88.01	
8.	72 91	87.97	
9.	72.91	87.97	
10.	72.91	88.00	
Av.	72.91	87.995	
Cor.	−0.174	+ 0.100	
	72.736	88.095	

15.359
7.5728
122872
30718
107513
76795
107513
0.2(116.3106352
0.9423)581.553176(617.16
56538
16173
9423
67501
65961
15407
9423
5984

Rise in Temperature 15.359
B. T. U. 617.16
Remarks *R. C. C.* Observer.

17. *Use of Computer.*—The labor of making the calculations for determining the heating value from observations of a calorimeter may be lessened by the use of a heating value computer, which has been designed by one of the members of the Committee. The computer consists of a circular slide rule, with divisions corresponding to the readings made on the calorimeter. This computer gives the corrected heating value of a cubic foot of gas in B.T.U.'s, having the barometer and temperature of the metered gas, and the difference in temperature between the inlet and outlet water and the pounds of water passed. This computer is designed to operate within the limits recommended by the Committee, and will give corrected heating value of the gas of from 300 to 800 B.T.U.'s. Should a gas of a lower or higher heating value than 300 to 800 B.T.U.'s be measured, the computer can still be used by dividing or multiplying one of the other factors in its computation.

18. *Suggestions for Further Investigation.*—Your Committee, knowing that much could be learned by further investigation of the subject of calorimetry, suggests the following topics, not with the idea that their investigation is necessary as an adjunct to commercial calorimetry as at present practiced, but as a means of further enlightenment on the general subject as affecting close and scientific determinations:

Effect on calorific readings resulting from a varying atmospheric humidity. Effect on heating value resulting from a difference in temperature between the inlet water and room atmosphere. Determination of heat lost through the products of combustion leaving the calorimeter above or below the atmospheric temperature.

Chapter VI.—Single Standard of Gas Valuation.

It has long been known by those having to do with the regulations governing the quality of gas to be supplied to the public, that the candle power required for certain kinds of gas has been much greater than that required for certain other gases. The difficulty of accurately expressing the utility value of the gas by candle power has been generally recognized by the more careful investigators, municipal and State, endeavoring to do the regulating, and by gas engineers whose work is vitally affected by this regulation. Therefore, it seems pertinent that some step should be taken whereby the product supplied could be more equitably compared and more readily referred to some serviceable standard or unit. This is particularly true under the present practice of supplying a mixture of several kinds of gas in varying proportions. It is also true because of the great strides which have been made in the production of more efficient apparatus for the transformation of the heating value of gas into light, that the relative value of flame luminosity and candle power has become less.

The proportion of gas actually used for purposes, where its candle power is of prime importance, is quite small, and becoming smaller. For all other purposes, such as heating, power, lighting by use of the incandescent mantle and similar devices, the heating value is clearly and beyond argument the simplest, clearest and the most satisfactory method of commercially valuing the gas. This being so, the question has been raised in the minds of many as to whether we were not unnecessarily encumbering our regulations; whether we were not adding unnecessary complications to our testing and hampering the best commercial development of our gas works and gas making processes by the use of a double standard.

The investigations of this Committee, we believe, would go to show that the heating value can be easily and definitely determined, that the process of making this determination is a comparatively simple one, and that with proper instruments the personal error is small; that, therefore, this method of testing the value of a given gas is decidedly preferable to the photometric method, for the reasons expressed above.

We, therefore, respectfully submit the question for the careful consideration of the Institute, and suggest that it be passed on to next year's Technical Committee for further study, looking to a definite recommendation to the Institute at the 1909 meeting.

In this connection, we would call to your attention the pioneer work in this direction, which has been done by the experts of the Wisconsin State Railway Commission, which has tentatively established standards for the State of Wisconsin calling for a single standard of value, the single standard adopted being the calorific value in terms of the entire, or so-called, "gross" heating value, expressed in British Thermal Units. Respectfully submitted,

R. B. Brown, Chairman,
C. F. Burgess,
J. B. Klumpp,
} Sub-Committee.

(To be Continued.)

The Financial Problems of the Manager.

[Communicated by Mr. Frank T. Hulswit, President of Child, Hulswit & Company, on the occasion of the Grand Rapids Convention of the lighting properties operated by that Company.]

When the management of this convention assigned to me the subject of "The Financial Problems of the Manager," I felt greatly honored to be allowed to express some ideas on this most important subject, but after listening to the very able papers of last evening and to-night, I realize strongly my weakness along oratorical lines and I crave your pardon if, in some of my remarks, I am not as eloquent as the preceding gentlemen. I hope that I may drop some hints and ideas which may be used to particular advantage by those present, and suggesting a very frank criticism of anything that is said, in order that I may gain by the valuable ideas which no doubt all of you can bring to bear on the subject.

Let us take, before entering into the actual discussion of the subject, a look backward, to October 1, 1904. On that date, Child, Hulswit & Co. started in business, in one small room, with Mr. Child and

myself as officers, bookkeepers and stenographers – with a great deal of confidence and a small amount of cash.

We have steadily grown, until to-day we occupy a creditable suite of rooms in the best office building in the city, and our payroll now covers 12 people. From the acquiring of the Cheboygan (Mich.) Gas Light Company, with a bonded and stock capital of $150,000, we have grown until to-day the total bonded and stock capital of the properties under our management exceeds $5,500,000. Our properties to-day pay out annually for interest, dividends and sinking funds, nearly $200,000. We pay in taxes in excess of $25,000.

Starting with a total investment in the Cheboygan Gas Light Company, of $50,000 of property, a most conservative valuation of the replacement value of the plants to-day, would be about $3,250,000.

It is needless to say that the "Home Office" keenly feels the immense responsibility to its friends and investors, who have entrusted this organization with so large a trust and responsibility, and if I do not accomplish more to-night than to impress upon you men your great share of the burden of the handling of the property of which you are directly in charge, I will feel that my effort has not been in vain.

It is of immense importance that each of you realizes to the fullest extent the sacredness of the trust reposed in him; primarily by the "Home Office," but more especially by the bond and stockholders who have entrusted you with the handling of a portion of their means. It is essential to success that there exist a spirit of absolute co-operation with the "Home Office," and a perfect understanding of all questions that may arise. The central organization, through its influence and friends, can be of large assistance to you in the handling of your finances, but only so far as you are absolutely frank in stating your financial requirements, backed up by arguments that are convincing, which call for expenditures that you have demonstrated will produce results.

There is a tendency, when crowded by neighborhood public opinion, to recommend to the "Home Office" expenditures for extensions of mains and services, which on the face will not show financial returns warranting the placing of these extensions. And while there is a general order governing this work, we do not wish you to feel that this order is an ironclad one, which, if a peculiar circumstance arises, does not warrant you to give us good reasons for making such extensions; for, in some instances, valuable business might be lost to competitors if the extension were not made at the proper moment. I simply wish to emphasize, however, that no money must be spent along these lines—or for that matter, along any other lines—that after a most careful study does not show a financial return larger than the interest on the money required to be used to make the expenditure. I also wish to call your attention, and caution you, to most carefully scrutinize your estimate of expenditures sent in to this office, for two reasons:

First. If your estimate of expenditure was too low, and it is O.K.'d, and you proceed with the work and find, upon completion, that you have spent more than was authorized, you put yourself in the position of exercising poor judgment in the situation.

Second. If you place your estimate of proposed expenditure too high—in fact, puposely so, in order to show that you were able to effect the completion of the work for less than called for, thereby hoping to get credit as a painstaking and saving manager—you run the risk of having the expenditure turned down by the "Home Office" because it looks too high.

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Reviewing this brief paper, I hope I have impressed upon you, as I have tried to do, that a manager must be more than a mechanical man; that he must be more than an office man; that he must also be in every essential a business man in the largest sense of the word; for he has problems which a business man, not engaged in manufacture, does not have to meet.

The financial and the operating departments are absolutely inter-

dependent upon each other; for, lacking the finances, the plant cannot purchase the necessary additional machinery and extensions to its property that a plant in a growing town demands. Likewise, the financing of the improvements becomes a very serious, if not almost impossible task, if proper operating conditions are not in effect. There is no wisdom in increasing the investment in the plant and property and increasing the gross earnings unless we manage to save out of the increased gross earnings a large increase in net—meaning reduced operating expenses; these reduced operating expenses, not to be at the expense of a proper maintenance of the property in a high state of efficiency, but made by the most careful scrutiny of the smallest expenditure, and the cutting off of every frill that is not essential.

As we take a backward look over the past 12 months, we are inspired with a sense of pride at the results which were obtained, and now let us look forward to the next 12 months' period with a renewed resolve to achieve still larger and better results. I trust next year, when we come to the anniversary of this, our First Managers' Convention, we may have the pleasure of looking in the eye and shaking the hands of the same men who are with us this evening; proud of the achievements that you men, and we, have jointly worked out during the year.

Correspondence.

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Some Useful Ways for Applying Electric Heat.

MIFFLIN COUNTY GAS AND ELECTRIC CO., GAS DEPARTMENT,
LEWISTOWN, PA., Nov. 25, 1908.

To the Editors AMERICAN GAS LIGHT JOURNAL: Your issue of November 23d contains an editorial headed "Electric Heating." I take slight exception to the following paragraph therein:

"The sole advantage of electric heating appliances lies in the matter of convenience, and this is an almost negligible quantity when compared with gas."

I beg leave to suggest a few applications of electric heating where it is not only a great convenience, but almost an absolute necessity, and where gas heating would not do at all. For instance: We supply electric current to an artificial ice and cold storage company. The storage vaults contain eggs, beer, meat, apples, etc., the temperature of each vault varying a degree or so from the other. To get the exact temperature required, and to give off no odor, or products of incomplete combustion that might contaminate the contents of the vaults, was the problem. A small, 3-heat electric radiator, with a minimum capacity of 200 watts, placed inside each vault, fills the bill exactly. In this case, the thermometer and hygrometer inside the vault can be seen through a small opening fitted with glass, and either the amount of moisture in the atmosphere or the temperature may be brought to the desired degree by a 3-heat switch, placed outside the vault, which avoids the opening of the vault door.

This company also ships eggs by freight in winter, using refrigerator cars for the purpose. They heat the car to a temperature of 60° F. before closing the door, thus delivering the eggs a distance of 200 miles without freezing in the coldest weather. It was found that the fumes given off from a gas stove or coal stove were bad for the eggs, and that a 4-kilowatt capacity electric radiator does the work, nicely and most conveniently, at a cost of 25 cents, in zero weather, paying 6 cents per kilowatt hour for electricity.

We have also found that, for a slight additional heat required in a sick room or nursery, there is nothing else so desirable, from a standpoin of convenience or good, pure air in the room, as an electric radiator, and one does not have to be very wealthy to be able to make use of it. Of course, you can't heat a whole house economically with electricity; that is out of the question. Neither can you do it with dollar gas.

Everyone at all interested knows the electric sad iron to be a great success. Even the smallest central stations have hundreds in use on their circuits. You will, I know, admit that it has the gas iron "backed off the boards."

A customer of ours, living in a flat where gas was the only means of cooking, found the gas pipes frozen one morning, and, without any great inconvenience, proceeded to cook her breakfast on an electric flat iron. This fact we will vouch for on our honor.

I could go on giving several more instances where electric heating has special advantages, but do not care to take more of your time.

Yours very truly, E. F. MCCABE.

Items of Interest
FROM VARIOUS LOCALITIES.

MR. E. C. WHITE, Eastern Representative of the Western Gas Construction Company, reports that the Company has been awarded the contract to erect for the Susquehanna Silk Mills, of Sunbury, Pa., a double-lift holder up to retaining 100,000 cubic feet. The mill people will take their gas from the local suppliers.

IN connection with this contract it is worthy of note that the boiler and machine shops of the Western Gas Construction Company are now running on full time—10 hours each day, save Saturday. On the last day of the week the shops are closed at noon. And so did Mr. Guldlin and his associates make good their pre-election pledges.

CHAUNCEY GAGE, Judge of the Circuit Court for the Saginaw (Mich.) district, has handed down his decision in the case of the action brought by the proprietors of the Saginaw Gas Light Company to have the 90-cent gas rate, as prescribed by the local authorities, declared illegal, in that such price was held as confiscatory. The opinion sustains the Company's contention. This case has been in the courts for possibly 2 years, and the sum of 10 cents per 1,000 (which represents the difference the Company would agree to charge, and the price the city demanded in the ordinance) has been meanwhile deposited with the Court, awaiting final adjudication, and amounts to not far from $50,000. The authorities will appeal, even though Judge Gage flatly declares (though he admits the authorities have the right to fix the rate) such rate must be in no sense confiscatory.

THE proprietors of the Galesburg (Ills.) gas supply, in seeking an extension of their charter rights, offer to supply gas at the uniform rate of $1 per 1,000 cubic feet, for a period of 10 years after the signing of such amended charter rights. At the end of such period it is agreed that the price for the succeeding 10 years shall be fixed by a board of 3 arbitrators, one of these to be named by the city and one by the Company, they two to name a third.

THE price paid at auction for the plant and rights of the New Bern (N. C.) Lighting and Fuel Company was $40,000, the purchaser being Mr. S. W. Smallwood, acting for the bondholders. This is the property for which Mr. G. A. Nicoll acted so well as receiver.

MR. J. LUSH, President of the New York Improved Meter Company, informs us that his Company has entered into arrangement with the Northwest Gas Equipment Company, of Portland, Ore., for the sale of its regular and prepayment types of meters. To insure prompt deliveries the Agents will carry suitable stocks of goods.

SOME time ago we noted the sale at auction of the Suffolk (Va.) Gas Company at the instance of the Receivers—Messrs. D. S. Mills and Jas. M. Burgess—and its purchase by Mr. King, President of the Columbia Trust Company, of New York. In connection with this property it is notable that when the plant was put in the hands of receivers (about the middle of last March) Mr. W. H. Fritchman was appointed Engineer and Manager. He seems to have been on the job about all of the time, for the accounts handed in by him to them on the day of the sale showed that in his custody $7,000 had been collected, and that not a dollar was due on any gas account, save such sums as were owing for gas used but not billable until the first inst. Well done; thou good and faithful—also, active—servant, may without irreverence be said over this showing.

WRITE to Mr. E. C. Pierce, Manager of the Crane Department, the Brown Hoisting Machinery Company, of Cleveland, O., for a copy of the Company's beautifully done "Bucket Catalogue." It lists completely the excellent line of buckets made by the Company. The catalogue shows also excellent illustrations of its automatic dumping tubs, shovel buckets, etc.

MR. F. M. SACKETT, President of the Louisville (Ky.) Gas Company, is authority for the statement that the Board of Arbitration will not order an increase in the selling rate, as a result of the examination of its books by the Board, since the content of the books does not show that the Company's earnings are in excess of 8 per cent. per annum. The Board examines the books under statutory direction once in 5 years, and if that examination shows the Company is earning over 8 per cent. per annum the examiners may report to City Councils the

rate that is deemed proper to keep the net earnings within the stipulated per cent.

THE Green Mountain Electric Company, of Burlington, Vt., has organized for the purpose of constructing, acquiring, owning and operating gas and electric lighting companies, and to carry on a general contracting business. The incorporators are: E. E. Larrabee, O. M. Barber and E. B. Broughton, of Bennington, Vt.; H. O. Larrabee and J. E. Davidson, of Montpelier, Vt., and F. W. Nichols, of Barre, Vt.

THAT Mr. A. J. Stahl, of La Porte, Ind., is satisfied with the way things in the artificial gas line are going on at that point would seem to be indicated by his recent purchase of 2 acres of land adjoining the present plant, on which site a new generating house will be constructed next spring. The planning also includes the construction of an additional storage holder, to be of the 2-lift order and rated to retain 100,000 cubic feet.

THE Board of Trustees of Greece, N. Y., have returned a favorable answer to the petition of General Manager R. M. Searle, of the Rochester Railway and Light Company, and associates, who asked that they be permitted to there supply gas and electrical currents. The franchise is perpetual, but not exclusive. If the Company desires to exercise the function under the grant, it is declared that it must supply gas to any applicant living within 300 feet of a gas main, and furnish electricity to anyone within 500 feet of a feed wire. It is also provided that mains or wires shall be extended when the applicants for service average 1 to every 500. The rates for both gas and electric service are to be at all times equal to those charged on like accounts in Rochester.

"LET justice be done though the heavens fall." I am impelled to this hoary sentence through just having read in a recent issue of the Baltimore *American* that last week Judge N. Charles Burke, in the Circuit Court, District of Towson—a suburb of this city—in the case of the Southern Investment Company against the Electric Park Company, directing that Lloyd L. Jackson and George A. Finch, Receivers of the latter Company, shall pay to the Consolidated Gas, Electric Light and Power Company $28, the value of one meter. The court further directed that the said amount shall be paid out of the assets of the Electric Park Company, and if there are no assets the receivers shall pay the sum personally.—V. W."

"P. T. L.," writing from Norfolk, Va., under date of the 29th inst., says: "Of course you have heard that the lighting properties and franchises of the Suffolk gas works, now or recently in the hands of the receivers in suits by Frederick C. Marston and the Columbia Trust Company, have been sold to Richard Roberts for $33,000. Also, that Special Master W. Leigh Williams recommends the confirmation of the sale, and that creditors are cited to appear in the Federal Court, Richmond, Va., December 7th, to show cause, if any, why the sale should not be confirmed. 'Down this way' we are priding ourselves on the noble, self-sacrificing propensities of the Suffolk auctioneer who 'knocked off' the properties, in that he charged only $15 for a sale involving the ultimate sum of $33,000. An honest man he must be; a cheap one beyond peradventure."

ANOTHER hint from the above direction—Norfolk, Va., under date of the 28th ult.—is to the effect that Federal Judge Waddill, following the resignation of Walter Whetstone, of Philadelphia, as one of the receivers of the Virginia Public Service Corporation, as to its lighting properties at Hampton and Phœbus, Va., has entered an order continuing Judge Sydney J. Dillon as sole receiver of the properties.

AT the annual meeting of the Suffern (N. Y.) Gas Company the officers elected were: Directors, Messrs. D. W. La Fetra, S. H. Pennington, Edward Oakes, M. T. Welsh, A. H. Kelsall, Edgar Tilton, H. S. Willard and S. F. Hayward; President, Edward Oakes; Secretary, D. W. La Fetra; Treasurer, S. H. Pennington.

THE shareholders in the Frontier Gas Meter and Appliances Company are notified that a meeting will be held, in the offices of Dempsey, Tuttle and Rice, Elderfield-Hartshorn Building, Niagara Falls, New York, at 10 A.M. of the 15th inst. At that time and place a proposition for the dissolution of the Company will be voted upon.

MR. LORING J. HAUCK has been elected President of the Cincinnati (O.) Gas and Electric Company, vice Mr. Charles P. Taft, resigned. A Vice-President was also elected, in the person of Mr. Stephen R. Burton.

MESSRS. W. F. BOARDMAN and C. C. Gardner, of San Francisco, have become interested (likely to the controlling point) in the Home Gas and Electric Company, of Redlands, Cal. It is proposed to extend the distributing system on a large scale, mainly in respect of the electric service.

THE Denver (Col.) Gas and Electric Company is arranging to expend a very large sum of money next year on its gas and electric lighting plants, the demand for both of which currents has increased enormously within the past 3 months. The particular item on construction account which has been agreed to is a storage holder up to retaining 3,000,000 cubic feet. Just think of it! A 3 million holder for Denver! What would be said of and to the one who, 10 years ago, prophesied that Denver would soon need a storage holder of the capacity noted?

SOME time ago we noted that the proprietors of the Beatrice (Neb.) Gas and Power Company had offered a series of prizes (10 in number) to those who were the first to send in correct answers to a question as to what would be the cost of baking a pan of biscuits, the gas consumption, price of gas, and time required to bake being given. The competition was quite a brisk one, and many housekeepers, along with those who thought their time as such was nigh, sent in a syllabus. The answer adjudged the best was submitted by Ruth A. Corn, whose findings were thus worked out: "In 60 minutes a Vulcan gas range consumes 33 cubic feet of gas. In 1 minute it would consume $\frac{1}{60}$ of 33 cubic feet, or .55 cubic feet. In 7 minutes it would consume 7 times .55 cubic feet, or 3 85 cubic feet to bake a pan of biscuits. One thousand cubic feet of gas costs $1.18¼, 1 cubic foot of gas will cost .001 of $1.18¼, or $.0011876; 3 cubic feet of gas will cost 3.85 × $.0011875 = $.004571875, or the money it will cost to bake a pan of biscuits on a Vulcan gas range."

"T. B. M.," sends the following brief mention from Boston, under date of the 29th ult.: "I failed to note any mention in the JOURNAL of the death of Mr. John P. Griffin, who passed away about mid-November. For 20 years deceased occupied a desk in the West street offices, first in the service of the Boston Gas Light Company, and later with its successor, the Boston Consolidated Gas Company. Plain and unostentatious, he was well-liked by his fellow clerks, and was much esteemed in the Catholic circles of the city. The funeral services were held in the Church of St. Thomas, the mass of requiem being sung by the Reverend Thomas Magennniss. Interment was subsequently made in Calvary Cemetery."

THE plant of the Parkesburg (Pa.) Gas Company, which is being constructed at that place under the immediate direction of Mr. C. F. Cattell, is well underway. The buildings, which are to be of brick, are to have the dimension of 66 feet 2 inches by 38 feet 2 inches, and the roof structure is to be of iron and slate and of a novel pattern. Each room in the building will be large enough to accommodate duplicate generating machines, boilers, etc. Two 6-foot water gas sets will go in at the start, and the coal supply will be cared for by an excellent system of tracks, bins and overhead apparatus. Oil storage up to taking care of 15,000 gallons has been arranged for, and the outset holder capacity contracted for is less than 110,000 cubic feet. The generating and boiler rooms are all on the same floor, from plans prepared by Mr. Cattell, who, in fact, designed the whole system. The Pennsylvania Railroad passes close by the buildings, and an ample water supply is set out. The main system of the Company (cast iron) comprises an 8-inch leader, and it is agreed that no pipe less than 3 inches in diameter will be placed.

THE demonstration cooking lectures given by the Alton (Ills.) Company last month were the best attended of any ever given by the Company. As was to be expected, several orders for ranges, right in the face of the coming winter, were booked.

ONE would not think that such a state of affairs could exist in a property that was being operated for the benefit of the residents of any community and with a hope of getting some financial return from such operation. However, here is the result of an examination of the plant of the Catskill (N. Y.) Power and Illuminating Company, made at the instance of the Public Service Commission, Second New York District, by its Chief Gas Inspector, Mr. C. H. Stone. The order of the Commission is directed to the notice of Mr. S. C. Wiley, President of the Company:

"*Ordered*, That said Catskill Illuminating and Power Company, be and is hereby directed to show cause before this Commission, at its rooms in the Capitol, Albany, at 2 o'clock in the afternoon of November 25th, or as soon thereafter as counsel may be heard, why an order should not be entered by this Commission requiring said Company forthwith to provide and install at its works, in the said village of Catskill, for use in the manufacture of gas, a tar extractor, an exhauster and an additional purifying box, and to take steps looking forward to the construction at an early date of an additional gasholder; and why this Commission should not order such other and further relief in the premises as may be deemed necessary, and as will best promote the public interest, preserve the public health and security, and protect those employed by said Company in the manufacture and distribution of gas."

THE appeal of the Chemung County Gas Company, of Elmira, N. Y., in respect to a reduction of the valuation put this year upon its properties by the Board of Supervisors for purposes of taxation was not without avail. Under the ruling of the court the assessment was reduced to $182,000; the original or appealed from valuation was $250,000.

IT is said that the cost of the 24-inch line in which it is proposed to convey natural gas from a point in Oklahoma to St. Louis, Mo., will be not less than $14,000,000. It is further said that the couplings will cost $\frac{1}{7}$ of that sum.

IT is said that the plant of the Louisville (Ky.) Lighting Company, which electrical concern is owned outright by the Louisville Gas Company, is capable of maintaining in circuit 600,000 lamps, each of 16-candle power.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

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NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand anytime of Wednesday.

AGENTS:

New York—American News Company, 39 and 41 Chambers street.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime street, London.

MONDAY, DECEMBER 7, 1908.

The Market for Gas Securities.

Consolidated went beyond 167 this week, then lost the major part of the gain, and now (Friday noon) is 164¼ bid, or a net advance for the week of 2 full points. The situation as to quotations in these shares now looks a trifle odd for the moment, but that the top has been reached, even for the balance of the year, is not our belief. It should certainly reach 175 before the rate decision is made public.

Brooklyn Union is also on the up end. Peoples, of Chicago, steadily holds its advance to par, and Massachusetts Companies' shares, when the full effect of its recent purchase of the Richardson gas interests is comprehended, should easily go to 75.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

DECEMBER 7.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated Gas Co.	$73,177,000	100	164¼	164½
Central Union Gas Co.—				
1st 5's, due 1928, J. & J.	3,000,000	1,000	98	101
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	3,500,000	100	130	160
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	100	102
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	100	101
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	86	91
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	148	150
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	299,650	500	130	—
Out-of Town Companies.				
Bay State	30,000,000	50	1⅛	2
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,660,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	29,500,000	100	89¾	89¾
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	92	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90½	91
Preferred	3,026,500	100	75½	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	105
Mortgages, 6's	3,000,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	—	—	74½	75
Detroit City Gas Co	5,000,000	50	—	50
" Prior Lien 5's	4,619,000	1,000	97	100¼
Detroit Gas Co., 5's	381,000	1,000	75	80
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	112	113½
" Bonds, 5's	10,500,000	—	103	103¾
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	200,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis.	10,000,000	100	—	100
Preferred	2,500,000	100	60	90
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,370,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	60¼
Massachusetts Gas Companies, of Boston	25,000,000	100	57	57¼
Preferred	25,000,000	100	89	89¼
Montreal Gas Co., Canada	9,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	100	100¼
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	92	—
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	96¼	—
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	102	—
Washington (D. C.) Gas Co.	2,600,000	20	337½	347½
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	230	—

Advertisers' Index.

GAS ENGINEERS. Page
Bartlett, Hayward & Co., Baltimore, Md. ...1005
Cruse-Kemper Co., Philadelphia, Pa. ... 992
Davis & Farnum Mfg. Co., Waltham, Mass. ...1004
Economical Gas Apparatus Construc. Co., Toronto, Ont. 1003
Evens & Howard Firebrick Co., St. Louis, Mo. ... 993
Frank D. Moses, Trenton, N. J. ...1008
Frederic Egner, Norfolk, Va. ...1008
Frederick J. Mayer, New York City ... 989
H. M. Byllesby & Co., Chicago, Ills. ...1004
Humphreys & Glasgow, New York City ...1004
Improved Equipment Company, New York City ... 990
Isbell-Porter Co., Newark, N. J. ... 992
Kerr Murray Mfg. Co., Fort Wayne, Ind. ...1005
The Gas Machinery Co., Cleveland, O. ... 988
United Gas Improvement Co., Philadelphia, Pa. ... 999
Western Gas Construction Co., Fort Wayne, Ind. ...1012

GAS WORKS APPARATUS AND CONSTRUCTION.
Bartlett, Hayward & Co., Baltimore, Md. ...1005
Connelly Iron Sponge & Governor Co., New York City. 1001
Continental Iron Works, Brooklyn, N. Y. ...1006
Cruse-Kemper Co., Philadelphia, Pa. ... 992
Davis & Farnum Mfg. Co., Waltham, Mass. ...1004
Deily & Fowler Mfg. Co., Philadelphia, Pa. ...1006
Economical Gas Apparatus Construc. Co., Toronto, Ont. 1003
Evens & Howard Firebrick Co., St. Louis, Mo. ... 993
Frank D. Moses, Trenton, N. J. ...1008
Humphreys & Glasgow, New York City ...1004
Improved Equipment Company, New York City ... 990
Isbell-Porter Co., New York City ... 992
Kerr Murray Mfg. Co., Fort Wayne, Ind. ...1005
Lloyd Construction Co., Detroit, Mich. ... 994
Logan Iron Works, Brooklyn, N. Y. ...1008
Quintard Iron Works Co., New York City ... 993
R. D. Wood & Co., Philadelphia, Pa. ...1006
Riter-Conley Mfg. Co., Pittsburgh, Pa. ... 991
Stacey Mfg. Co., Cincinnati, O. ...1007
The Gas Machinery Co., Cleveland, O. ... 988
United Gas Improvement Co., Philadelphia, Pa. ... 999
Western Gas Construction Co., Fort Wayne, Ind. ...1012

PROCESSES.
Bartlett, Hayward & Co., Baltimore, Md. ...1005
Economical Gas Apparatus Construc. Co., Toronto, Ont. 1003
Humphreys & Glasgow, New York City ...1004
Improved Equipment Company, New York City ... 990
Semet-Solvay Co., Syracuse, N. Y. ...1004
The Gas Machinery Co., Cleveland, O. ... 988
United Gas Improvement Co., Philadelphia, Pa. ... 999
Western Gas Construction Co., Fort Wayne, Ind. ...1012

SCRUBBERS AND CONDENSERS.
Bartlett, Hayward & Co., Baltimore, Md. ...1005
Continental Iron Works, Brooklyn, N. Y. ...1006
Cruse-Kemper Co., Philadelphia, Pa. ... 992
Davis & Farnum Mfg. Co., Waltham, Mass. ...1004
Economical Gas Apparatus Construc. Co. Toronto, Ont. 1003
Evens & Howard Firebrick Co., St. Louis, Mo. ... 993
Isbell-Porter Co., Newark, N. J. ... 992
Kerr Murray Mfg. Co., Fort Wayne, Ind. ...1005
Logan Iron Works, Brooklyn, N. Y. ...1008
R. D. Wood & Co., Philadelphia, Pa. ...1006
Riter-Conley Mfg. Co., Pittsburgh, Pa. ... 991
Stacey Mfg. Co., Cincinnati, O. ...1007
The Gas Machinery Co., Cleveland, O. ... 988
Western Gas Construction Co., Fort Wayne, Ind. ...1012

PRODUCER POWER PLANTS.
Economical Gas Apparatus Construc. Co., Toronto, Ont. 1003
R. D. Wood & Co., Philadelphia, Pa. ...1006

TAR AND CARBONIC ACID EXTRACTOR.
Bartlett, Hayward & Co., Baltimore, Md. ...1005
Economical Gas Apparatus Construc. Co., Toronto, Ont. 1003
Isbell-Porter Co., Newark, N. J. ... 992
Kerr Murray Mfg. Co., Fort Wayne, Ind. ...1005
Stacey Mfg. Co., Cincinnati, O. ...1007
The Gas Machinery Co., Cleveland, O. ... 988
Western Gas Construction Co., Fort Wayne, Ind. ...1012

AMMONIA CONCENTRATORS.
Bartlett, Hayward & Co., Baltimore, Md. ...1005
Michigan Ammonia Works, Detroit, Mich. ... 995
The Gas Machinery Co., Cleveland, O. ... 988
Western Gas Construction Co., Fort Wayne, Ind. ...1012

GAS METERS.
American Meter Co., New York and Philadelphia. ...1011
D. McDonald & Co., Albany, N. Y. ...1009
Helme & McIlhenny, Philadelphia, Pa. ...1011
John J. Griffin & Co., Philadelphia, Pa. ... 993
Keystone Meter Co., Royersford, Pa. ...1010
Maryland Meter and Mfg. Co., Baltimore, Md. ...1010
Metric Metal Co., Erie, Pa. ...1011
Nathaniel Tufts Meter Co., Boston, Mass. ...1010
New York Improved Meter Co., New York City. ...1010
Pittsburg Meter Co., East Pittsburg, Pa. ... 994
Rotary Meter Co., New York City ... 987
Sprague Meter Co., Bridgeport, Conn. ...1009
United States Meter Co., Brooklyn, N. Y. ...1011

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia.....1011
D. McDonald & Co., Albany, N. Y..... 1009
Helme & McIlhenny, Philadelphia, Pa.....1011
John J. Griffin & Co., Philadelphia, Pa..... 968
Keystone Meter Co., Royersford, Pa.....1010
Nathaniel Tufts Meter Co., Boston, Mass.....1010
New York Improved Meter Co., New York City.....1004
Pittsburg Meter Co., East Pittsburg, Pa..... 994
Sprague Meter Co., Bridgeport, Conn.....1004

PREPAYMENT METER ATTACHMENTS.

New York Improved Meter Co., New York City.....1010

WATER METERS.

Pittsburg Meter Co., East Pittsburg, Pa..... 994

GAS AND WATER PIPES.

Davis & Farnum Mfg. Co., Waltham, Mass.....1004
Donaldson Iron Co., Emaus, Pa..... 996
Economical Gas Apparatus Construc. Co., Toronto, Ont 1003
R. D. Wood & Co., Philadelphia, Pa.....1006

GAS COALS.

Berwind-White Coal Mining Co., New York and Phila.1002
Perkins Co., New York City.....1002
Westmoreland Gas Coal Co., Philadelphia, Pa.....1003

GAS MAIN STOPPERS.

Edward A. Behringer, New York City..... 982
Safety Gas Main Stopper Co., New York City.....1001

MAIN AND SERVICE LAYING.

Sullivan Bros., Flushing, N. Y.....1003

GAS TAPPING MACHINES.

George Light, Dayton, O.....1003
H. Mueller Manufacturing Co. Decatur, Ills..... 994

CANNEL COALS

Perkins & Co., New York City.....1002

STOKING MACHINERY.

G. A. Bronder, New York City..... .1001

CONVEYORS—ALL KINDS.

Bartlett, Hayward & Co., Baltimore, Md.....1005
Brown Hoisting Machinery Co., Cleveland, O..... 996
Cruse-Kemper Co., Philadelphia, Pa..... 992
C. W. Hunt Company, New York City.....1004
Economical Gas Apparatus Construc. Co., Toronto, Ont.1003
G. A. Bronder, New York City.....1001
Kerr Murray Mfg. Co., Fort Wayne, Ind.....1005
The Gas Machinery Co., Cleveland, O..... 988
Western Gas Construction Co., Fort Wayne, Ind.....1012

CHARGING BARROWS & COAL WAGONS.

Davis & Farnum Mfg. Co., Waltham, Mass.....1004
Kerr Murray Mfg. Co., Fort Wayne, Ind.....1005
Stacey Mfg. Co., Cincinnati, O.....1007

GAS ENRICHERS.

Standard Oil Co., New York City.....1003

COKE CRUSHERS.

Bartlett, Hayward & Co., Baltimore, Md.....1005
C. M. Keller, Columbus, Ind.....1003

GAS METER CONNECTIONS.

H. Mueller Manufacturing Co., Decatur, Ills..... 994

GAS COCKS.

H. Mueller Manufacturing Co., Decatur, Ills..... 994

GAS GAUGES.

The Bristol Co., Waterbury, Conn..... 996

GAS GOVERNORS.

Chaplin-Fulton Mfg. Co., Pittsburg, Pa.....1007
Connelly Iron Sponge & Governor Co., New York City .1001
Evens & Howard Firebrick Co., St. Louis, Mo..... 993
Isbell-Porter Co., Newark, N. J..... 992
Pittsburg Meter Co., East Pittsburg, Pa..... 994
R. D. Wood & Co., Philadelphia, Pa.....1006
Reynolds Gas Regulator Co., Anderson, Ind.....1001

CEMENTS.

C. L. Gerould, Pittsburgh, Pa..... 1006

RETORTS AND FIREBRICKS.

Baltimore Retort and Firebrick Co., Baltimore, Md...1000
Didier-March Co., New York City..... 989
Evens & Howard Firebrick Co., St. Louis, Mo..... 993
Gas Bench Construction Co., St. Louis, Mo.....1000
Henry Maurer & Son, New York City..... 993
Improved Equipment Company, New York City..... 990
James Gardner, Jr., Co., Bolivar, Pa.....1002
J. H. Gautier & Co., Jersey City, N. J.....1000
Missouri Firebrick Co., St. Louis, Mo.....1000
Parker-Russell Mining and Mfg. Co., St. Louis, Mo.... 990

INCLINED RETORTS.

Baltimore Retort and Firebrick Co., Baltimore, Md...1000
Didier-March Co., New York City 989
Gas Bench Construction Co., St. Louis, Mo.....1000
Improved Equipment Company, New York City..... 990
Parker-Russell Mining and Mfg. Co., St. Louis, Mo... 990

VERTICAL S'S.

Connelly Iron Sponge & Gov. Co. (Drake's [Eng.] System)1001
Didier-March Co., New York City..... 989
Gas Bench Construction Co., St. Louis, Mo.....1000
Improved Equipment Company, New York City..... 990
Parker-Russell Mining and Mfg. Co., St. Louis, Mo... 990

REGENERATIVE FURNACES.

Baltimore Retort and Firebrick Co., Baltimore, Md..1000
Bartlett, Hayward & Co., Baltimore, Md.....1005
Didier-March Co., New York City..... 989
Gas Bench Construction Co., St. Louis, Mo.....1000
Improved Equipment Company, New York City..... 990
J. H. Gautier & Co., Jersey City, N. J..... 1000
Missouri Firebrick Co., St. Louis, Mo..... 1000
Parker-Russell Mining and Mfg. Co., St. Louis, Mo... 990

SELF-SEALING MOUTHPIECE DOORS.

Bartlett, Hayward & Co., Baltimore, Md.....1005
Continental Iron Works, Brooklyn, N. Y.....1006
Davis & Farnum Mfg. Co., Waltham, Mass.....1004
Isbell-Porter Co., Newark, N. J..... 992
Improved Equipment Company, New York City..... 990
Kerr Murray Mfg. Co., Fort Wayne, Ind.....1005
Logan Iron Works, Brooklyn, N. Y.....1008
R. D. Wood & Co., Philadelphia, Pa.....1006
Stacey Mfg. Co., Cincinnati, O..... 1007
The Gas Machinery Co., Cleveland, O..... 988
Western Gas Construction Co., Fort Wayne, Ind.....1012

INCANDESCENT GAS LAMPS.

General Gas Light Co., Kalamazoo, Mich..... 995
Welsbach Company, Gloucester, N. J..... 998

BURNERS.

Wm. M. Crane Co., New York City..... 996

STREET LAMPS.

Thos. T. W. Miner, New York City.....1003
Welsbach Street Lighting Co., New York and Phila.. 998

PURIFIERS.

Bartlett, Hayward & Co., Baltimore, Md.....1005
Connelly Iron Sponge & Governor Co., New York City .1001
Cruse-Kemper Co., Philadelphia, Pa..... 992
Davis & Farnum Mfg. Co.. Waltham, Mass.....1004
Isbell-Porter Co., Newark, N. J..... 992
Kerr Murray Mfg. Co., Fort Wayne, Ind.....1005
R. D. Wood & Co., Philadelphia, Pa.....1006
Stacey Mfg. Co., Cincinnati, O..... 1007
Western Gas Construction Co., Fort Wayne, Ind.....1012

VALVES.

Bartlett, Hayward & Co., Baltimore, Md.....1005
Continental Iron Works, Brooklyn, N. Y.....1006
Davis & Farnum Mfg. Co., Waltham, Mass.....1004
Economical Gas Apparatus Construc. Co., Toronto, Ont.1003
Isbell-Porter Co., Newark, N. J..... 992
Kerr Murray Mfg. Co., Fort Wayne, Ind.....1005
Ludlow Valve Manufacturing Co., Troy, N. Y..... 993
R. D. Wood & Co., Philadelphia, Pa.....1006
Stacey Mfg. Co., Cincinnati, O.....1007
The Gas Machinery Co., Cleveland, O..... 988
The P. H. & F. M. Roots Co., Connersville, Ind..... 995
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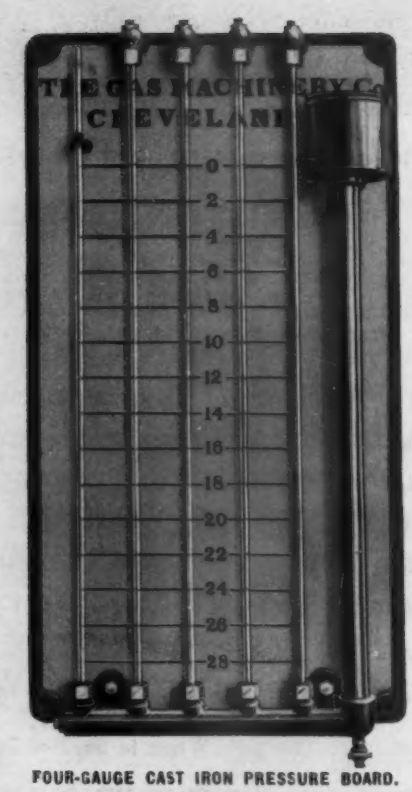

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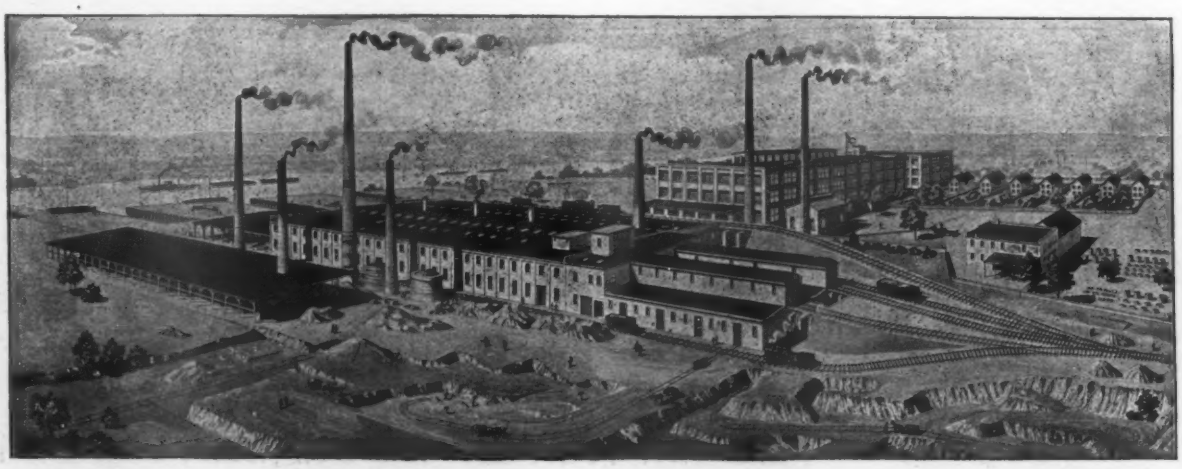

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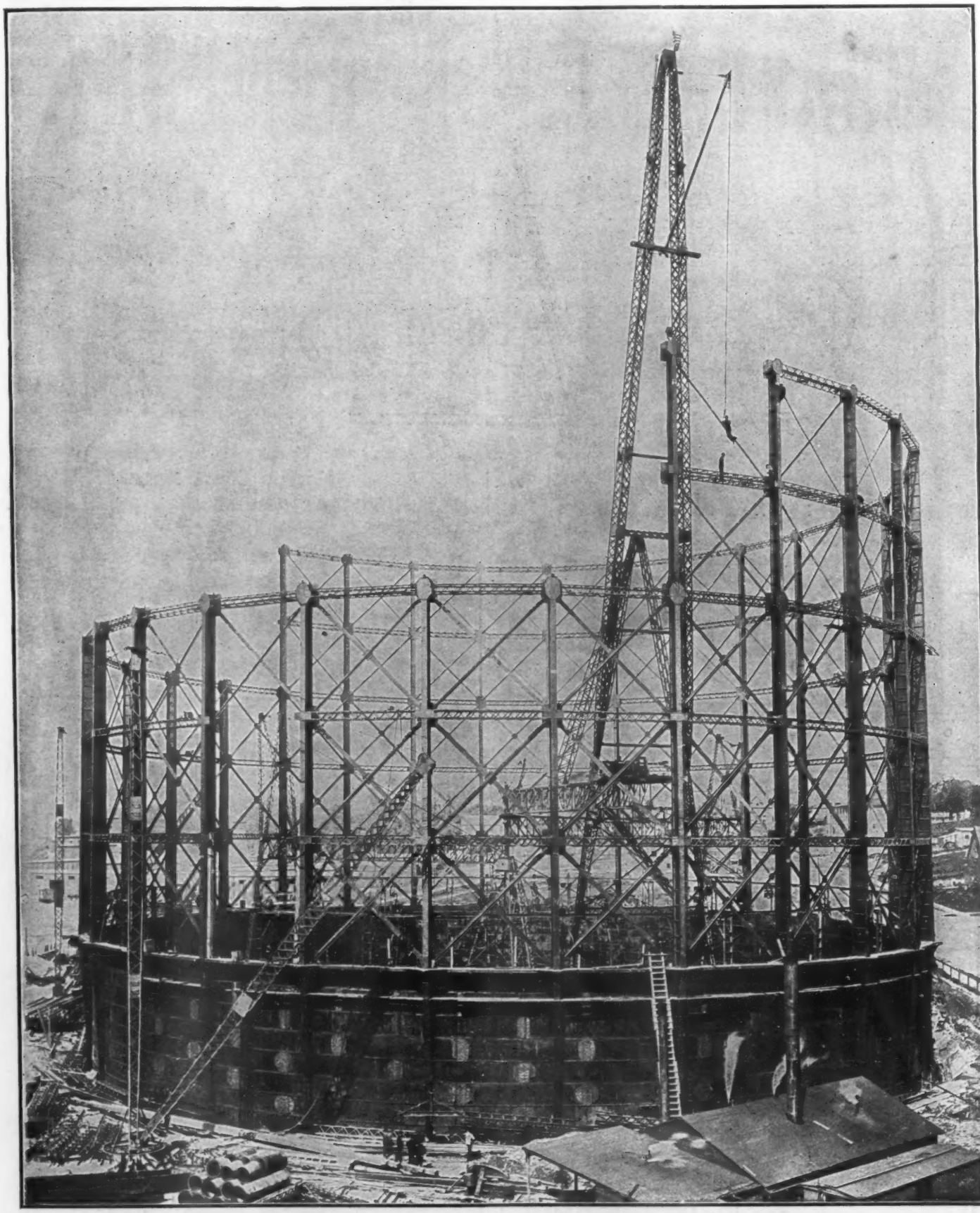

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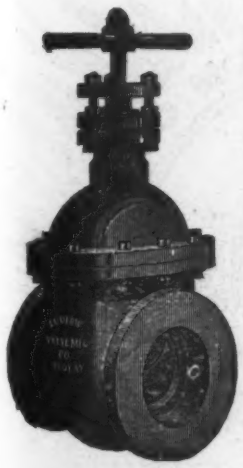

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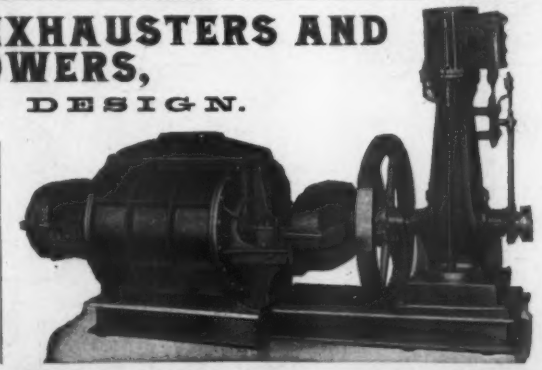

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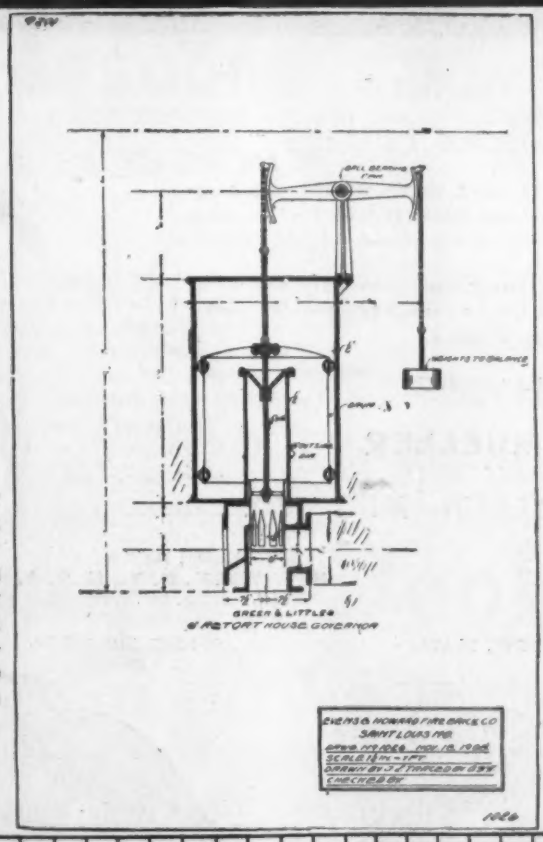

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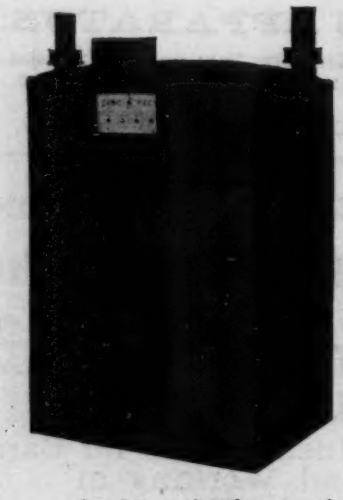

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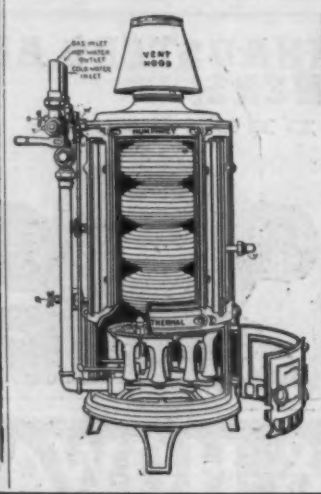

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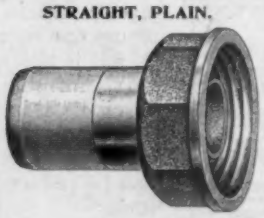

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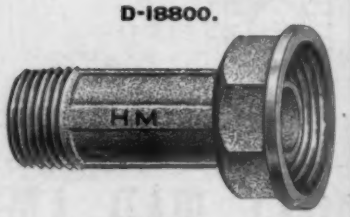

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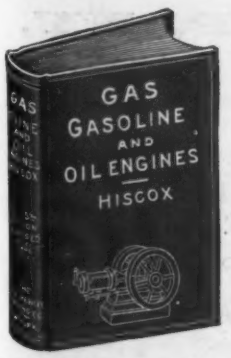

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It won't Flood the Mantle at 40-10ths Pressure.

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Anyone can adjust this burner, the layman as well as the expert.

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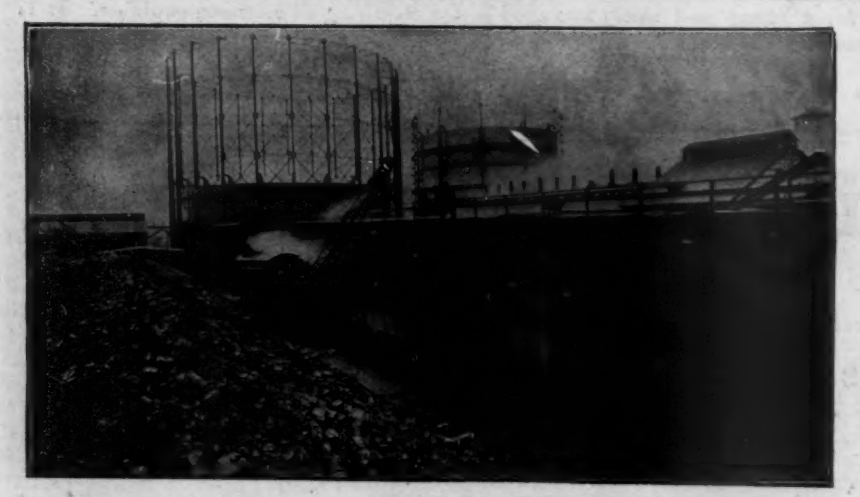

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PUBLIC LIGHTING TABLE.

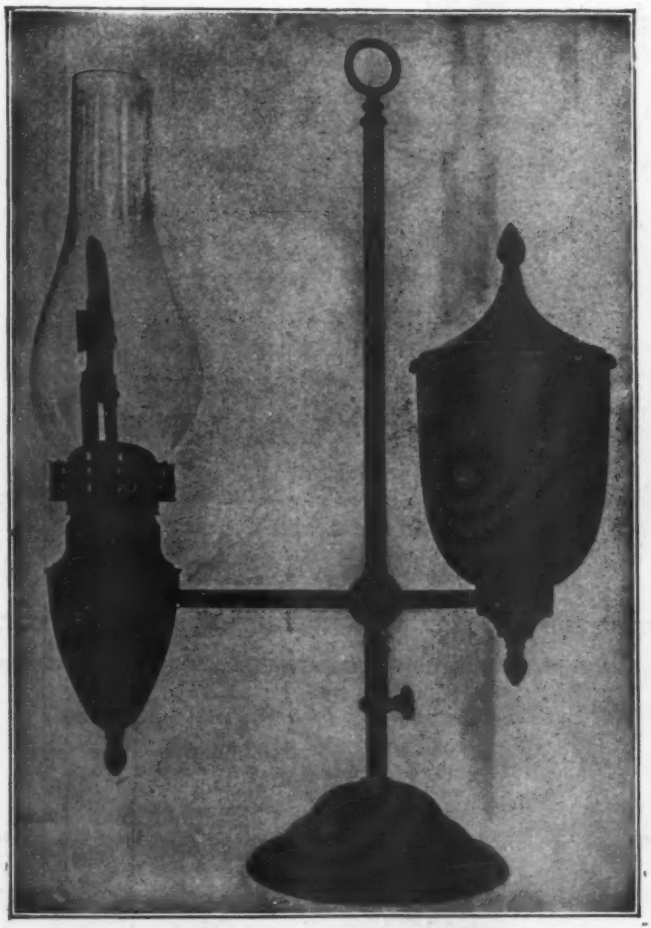
DECEMBER, 1908.

Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.
Tue.	1	12.00 PM	6.00 AM
Wed.	2	1.10 AM	6.00
Thu.	3	2.20	6.00
Fri.	4	3.30	6.00
Sat.	5	4.40	6.00
Sun.	6	No L.	No L.
Mon.	7	No L. FM	No L.
Tue.	8	No L.	No L.
Wed.	9	5.00 PM	7.10 PM
Thu.	10	5 00	8.00
Fri.	11	5.00	9.00
Sat.	12	5.00	10.00
Sun.	13	5.10	11.00
Mon.	14	5.10	12.00
Tue.	15	5.10 LQ	1.00 AM
Wed.	16	5.10	2.00
Thu.	17	5.10	3.00
Fri.	18	5.10	4.00
Sat.	19	5.10	5.00
Sun.	20	5.10	6.20
Mon.	21	5.10	6.20
Tue.	22	5.10	6.20
Wed.	23	5.10 NM	6.20
Thu.	24	5.10	6.20
Fri.	25	5.10	6.20
Sat.	26	5.10	6.20
Sun.	27	5.10	6.20
Mon.	28	9.50	6.20
Tue.	29	11.00 FQ	6.20
Wed.	30	12.10 AM	6.20
Thu.	31	1.20	6.20

TOTAL HOURS DURING 1908.

By Table No. 1.

	Hrs. Min.
January	228.30
February	187.30
March	192.00
April	160.10
May	155.10
June	138.00
July	155.50
August	173.40
September	185.20
October	214.00
November	218.10
December	226.40
Total, yr.	2235.00



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10-Candle Power.

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This lamp is a perfect substitute for the 10-candle Pentane Lamp hitherto used, and has the following advantages:

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2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

DECEMBER, 1908.

Day of Week.	Date.	Table No. 2. NEW YORK CITY. All Night Lighting. Complete Lighting in One Hour From Time Given P. M.	Complete Extinguishing in 50 Minutes From Time Given A. M.
Tue.	1	4.07	5.52
Wed.	2	4.07	5.52
Thu.	3	4.02	5.57
Fri.	4	4.02	5.57
Sat.	5	4.02	5.57
Sun.	6	4.02	5.57
Mon.	7	4.02	5.57
Tue.	8	4.02	5.57
Wed.	9	4.02	5.57
Thu.	10	3.57	6.07
Fri.	11	3.57	6.07
Sat.	12	3.57	6.07
Sun.	13	3.57	6.07
Mon.	14	3.57	6.07
Tue.	15	3.57	6.07
Wed.	16	3.57	6.07
Thu.	17	3.57	6.17
Fri.	18	3.57	6.17
Sat.	19	3.57	6.17
Sun.	20	3.57	6.17
Mon.	21	3.57	6.17
Tue.	22	3 57	6.17
Wed.	23	3.57	6.17
Thu.	24	4.02	6.22
Fri.	25	4.02	6.22
Sat.	26	4.07	6.22
Sun.	27	4.07	6.22
Mon.	28	4.07	6.22
Tue.	29	4.07	6.22
Wed.	30	4.07	6.22
Thu	31	4.12	6.27

TOTAL HOURS DURING 1908.

	Hrs. Min.
January	481.50
February	329.15
March	351.50
April	341.50
May	233.05
June	218.10
July	282.55
August	254.55
September	292.25
October	420.45
November	374.30
December	411.05
	3992.35
Deduct on account of 50 min. extinguishing time	30.30
Total, yr.	3962.05

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Uses Two Feet of Gas per Hour.

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Jenkintown, Pa. (2d contract).
Coney Island, N. Y.
Mexico, Mo.
Jacksonville, Fla.
Syracuse, N. Y. (2d contract).
Atlanta, Ga. (2d contract).
Holyoke, Mass.
Peoria, Ills.
Schenectady, N. Y. (2d contract).
Danbury, Conn.
Galveston, Tex. (2d contract).
Quebec, Canada.
Indianapolis, Ind. (2d contract).
Bessemer, Ala.
Waterbury, Conn. (5th contract).
Sioux Falls, S. D. (3d contract).
Philadelphia, Pa.
New Hartford, Conn.
Poughkeepsie, N.Y. (2d contract).
Nashville, Tenn.
Salisbury, Md.
Norfolk, Va. (4th contract).
Wallingford, Conn.
Richmond, Va. (2d contract).
Oak Bluffs, Mass.
Arlington, Mass.

TOTAL SETS INSTALLED DURING YEAR, ... 43
TOTAL SETS INSTALLED TO DECEMBER 31, 1907, ... 677
TOTAL DAILY CAPACITY, TO DECEMBER 31, 1907, ... 545,865,000 cu. ft.

Tar Extractors for Carburetted Water Gas.
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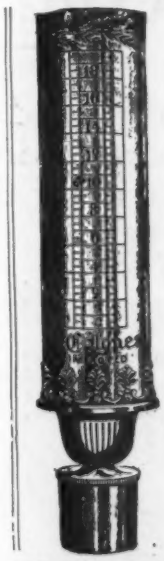

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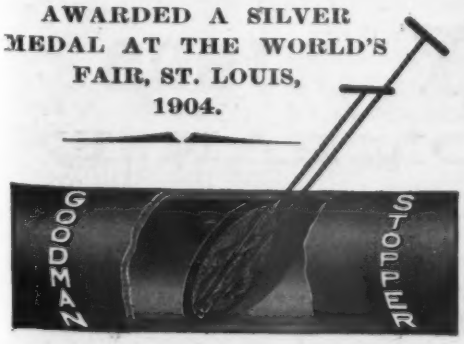

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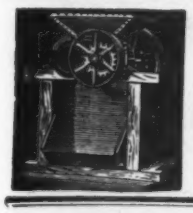

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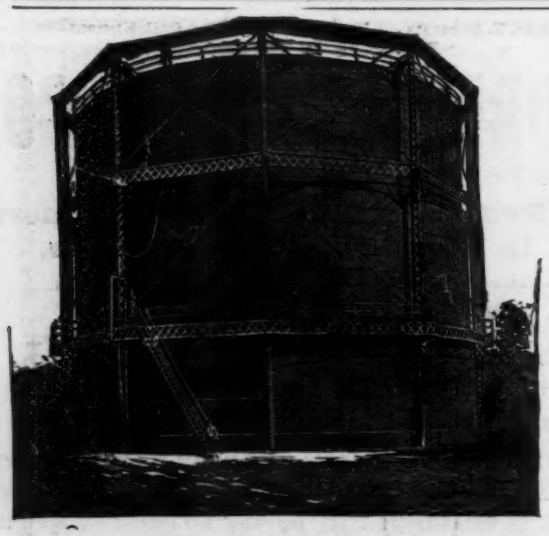

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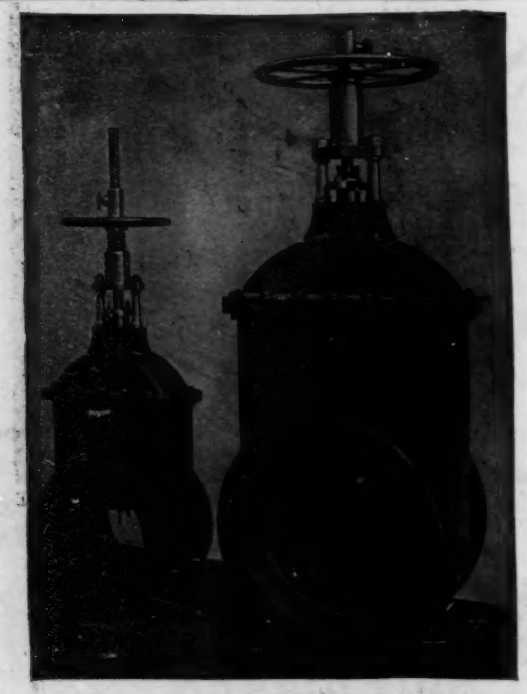

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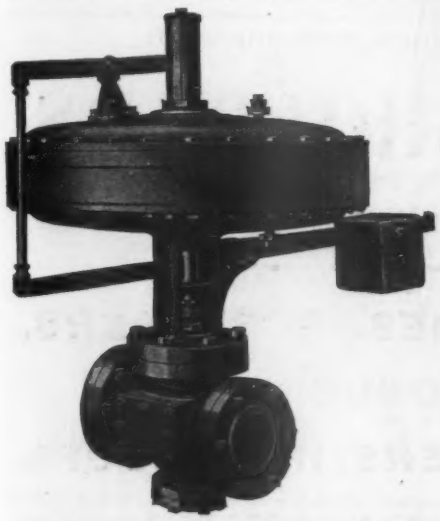

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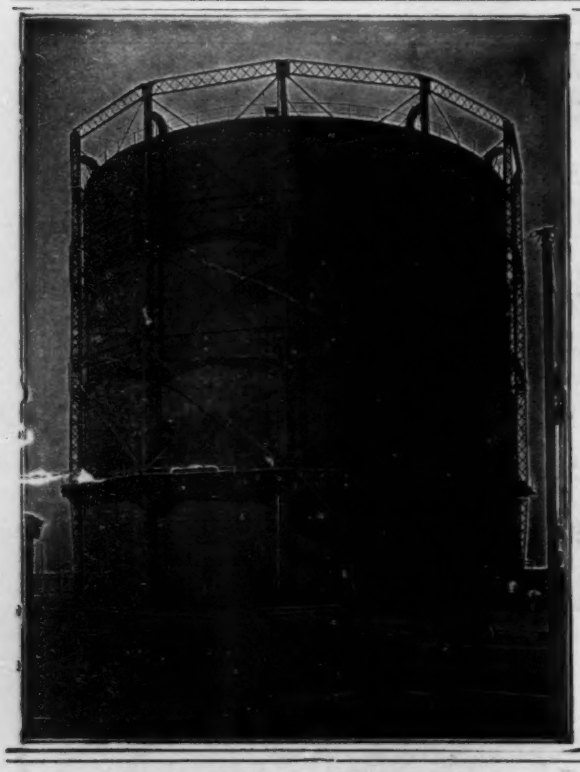

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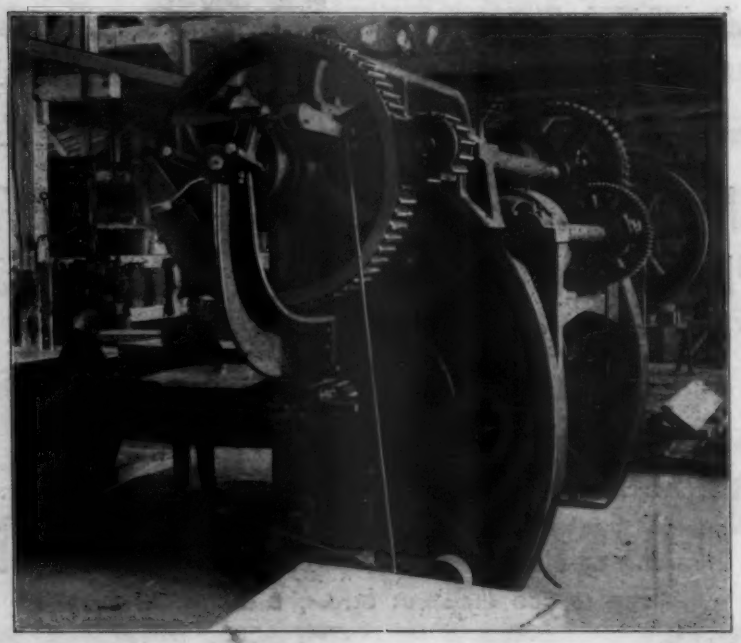

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